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TECHNOLOGY TRANSFER TEAM

APPLICATIONS OF AEROSPACE TECHNOLOGY

Final Report
November 23, 1982-December 31, 1983

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National Aeronautics and
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Langley Research Center
Hampton, Virginia 23665

TECHNOLOGY TRANSFER TEAM
Applications of Aerospace Technology

Final Report
November 23, 1982–December 31, 1983

by

Doris Rouse

RTI/2547/00-03F
NASA Contract No. NAS1-17214

Technical Monitor: Mr. John Samos

Technology Utilization and Applications Programs Office
Langley Research Center
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Hampton, Virginia 23665

PREFACE

This report documents the activities of the Research Triangle Institute's Technology Transfer Team program for the period 11 November 1982 through 31 December 1983. The work was performed in the Research Triangle Institute's Center for Technology Applications under the direction of Dr. D. J. Rouse. Dr. J. N. Brown, Jr., RTI vice-president, participated in the methodology development and management of the team. Assistance in establishing collaborative projects with the National Institutes of Health and other Federal agencies was provided by Mr. William Z. Penland, Jr., and Mr. Bernard Maggin, RTI consultants in Washington, DC. Other participants in the program were Dr. H. C. Beall, Mr. Robert Wallace, Mr. Art Keating, Dr. John Cleland, Mr. Tony Sigmon, and Ms. B. Bass. The team was assisted during the summer by Mr. Scott Fosko. Assistance in commercialization activities was provided by RTI consultant, Ms. Jane Nugent.

The work reported herein was supported by the National Aeronautics and Space Administration--Contract No. NAS1-17214. Mr. John Samos, Head, Technology Utilization and Applications Programs Office, Langley Research Center, was the technical monitor.

The authors gratefully acknowledge the contributions of many individuals to the success of the RTI Technology Transfer Team program. The time and effort contributed by Technology Utilization officers, managers, engineers, and scientists throughout the National Aeronautics and Space Administration were absolutely essential to program success. Industry managers and technical staff have always been cooperative and open in their participation. Continuing discussions with these industry representatives have enhanced the team's understanding of medical device manufacturing and marketing practices and constraints. Finally, Mr. John Samos has contributed significantly to the success of the program and, as a technical monitor, has always been supportive.

ABSTRACT

The objective of the Research Triangle Institute (RTI) Technology Transfer Team is to assist NASA in achieving widespread utilization of aerospace technology in terrestrial applications. Widespread utilization implies that the application of NASA technology is to benefit a significant sector of the economy and population of the Nation. This objective is best attained by stimulating the introduction of new or improved commercially available devices incorporating aerospace technology.

A methodology is presented for the team's activities as an active transfer agent linking NASA Field Centers, industry, industry associations, user groups, and the medical community. This methodology is designed to (1) identify priority technology requirements in industry and medicine, (2) identify applicable NASA technology that represents an opportunity for a successful solution and commercial product, (3) obtain the early participation of industry in the transfer process, and (4) successfully develop a new product based on NASA technology.

During the reporting period, the team planned and implemented transfer activities for 18 active transfer projects. One project was inactivated in the reporting period.

For the convenience of the reader, the names and addresses of the sources of commercial products are included in this report. This listing does not constitute an endorsement by either the National Aeronautics and Space Administration or the Research Triangle Institute.

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1.0 INTRODUCTION

The preamble to the Space Act of 1958, which created the National Aeronautics and Space Administration (NASA), states: ". . . it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind" (PL85-568). This Act of Congress further charges NASA with providing ". . . for the widest practical and appropriate dissemination of information concerning its activity and the results thereof." NASA's Technology Utilization Program was initiated in 1962 to assist in satisfying this Congressional obligation.

Since 1962, NASA has been a leader and an innovator in the establishment and operation of technology transfer programs. NASA's Tech Briefs, special publications, technology surveys, and Industrial Applications Center programs provide comprehensive access to the technology and information emerging from the Nation's space program. NASA is successfully transferring the results of aerospace research to the non-space-related sectors of society.[1] [2]

The Research Triangle Institute (RTI) has participated in this program since 1966, when it established one of the first three NASA Biomedical Applications Teams. The Institute has made a major commitment to the successful transfer of aerospace technology to applications in medicine and to a better understanding and advancement of the technology transfer process. Since 1982, the NASA Applications Team at RTI has broadened its targets for technology transfer to include manufacturing technology and rehabilitation as well as medicine.

1.1 Technology Transfer Team Objectives

The primary objective of the Technology Transfer Team program is to assist NASA in achieving widespread utilization of aerospace technology in the non-space-related sectors of the United States. Widespread utilization implies that the application of NASA technology is to benefit a significant sector of the economy and population of the Nation. Implicit in the program objectives is that widespread utilization be achieved as rapidly as possible. NASA's Technology Utilization program has been focused and shaped to a significant extent by Federal legislation. At present, the primary targets for this program, and more specifically for the RTI Technology Transfer Team, are:

- Manufacturing technology
- Rehabilitation
- Medicine.

Specific program objectives are:

- Increased industrial productivity
- New and more effective aids for the handicapped
- Improved medical diagnosis and treatment (includes cost reduction/containment).

The benefits of technology transfer or utilization are achieved only when a new product or process incorporating aerospace technology is made available to industry, the handicapped, and the medical sector. Therefore, the Technology Transfer Team has as its primary objective the commercialization of new products and processes incorporating NASA technology and intended for industry, the handicapped, and the medical field. The Technology Transfer Team methodology consists primarily of the following activities:

- Identifying target area requirements and problems and potentially applicable NASA technology that together constitute a new or improved product or process
- Screening these "commercialization opportunities" to find those that represent potentially successful commercial products and processes
- Developing commercialization strategies that take into account any necessary adaptation of NASA technology, evaluation and test, government regulations, manufacturers marketing systems, and the required funding
- Implementing and monitoring all phases of the commercialization strategies and plans.

These tasks are discussed in more detail in Section 2.0, Technical Approach.

1.2 Technology Transfer Team Staffing

The RTI Technology Transfer Team is a multidisciplinary team of engineers and scientists whose educational backgrounds include physiology, biophysics, engineering, biochemistry, business, and biomedical engineering and whose experience includes basic and applied research, product development, and marketing. The team is necessarily multidisciplinary in nature because the transfer of technology is an interdisciplinary process. That is, team members must communicate precisely and effectively with physicians, NASA scientists and engineers, industry representatives, and representatives of a variety of government agencies. Furthermore, the team must be able to deal with and contribute to the technical, clinical, financial, legal, marketing, and regulatory aspects of introducing new products. The individuals who participated in the RTI Technology Transfer Team program during the reporting period are:

Name	Professional background	Responsibility
Dr. D. J. Rouse	Biochemist, Physiologist	Director, RTI Technology Transfer Team
Dr. J. N. Brown, Jr.	Electrical Engineer	Team Management Consultant
Dr. H. C. Beall	Biophysicist, Physiologist	Solution Specialist
Dr. John Cleland	Mechanical Engineer	Solution Specialist
Mr. William Penland, Jr.	Engineer	Washington Consultant
Mr. Scott Fosko	Microbiology	Summer Intern
Mr. Bernard Maggin	Program Manager	Washington Consultant
Ms. Jane Nugent	Marketing Specialist	Commercialization Consultant
Mr. Art Keating	Biomedical Engineer	Solution Specialist
Mr. Tony Sigmon	Mechanical Engineer	Solution Specialist
Mr. Robert Wallace	Industrial Engineer	Solution Specialist
Ms. B. C. Bass	Resource Specialist	Solution Assistant

1.3 Participating Institutions

The Technology Transfer Team may be viewed as one component in a technology transfer network that involves NASA Headquarters, NASA Field Centers, medical institutions, manufacturing and marketing firms, the National Institutes of Health (NIH), the Food and Drug Administration (FDA), and other government agencies. Organizations and their roles in the technical process are listed below. Tables 1, 2, and 3 list the organizations participating in RTI team projects over the past year.

Organization	Role
National Institutes of Health Veterans Administration	Establishment of medical objectives and priorities and evaluation of devices
Department of Commerce, Department of Transportation, and other Federal Agencies	Establishment of objectives and priorities in non-medical applications

TABLE 1. PROJECTS WITH NASA FIELD CENTERS DURING REPORTING YEAR

AMES RESEARCH CENTER
- Digital Data Recorder
- Liquid-Cooled Garment Projects
  - Cooling Vests for Quadriplegics
  - Cooling for Multiple Sclerosis Therapy

GODDARD SPACE FLIGHT CENTER
- Cerebrospinal Fluid Control System
- Programmable Implantable Medication System

JET PROPULSION LABORATORY
- Corneal Topography
- Hydrocephalus Shunt--Ventilation

JOHNSON SPACE CENTER
- Female Incontinence Device

KENNEDY SPACE CENTER
- In-Flight IFR Simulator
- Wildlife Tracking

LANGLEY RESEARCH CENTER
- High Performance Wheelchair
- Microwave Thermography

LANGLEY RESEARCH CENTER (continued)
- Noninvasive Lung Diagnosis
- Portable X-Ray Fluorescence Spectrometer
  - Water Quality Monitoring
  - Metals Analyzer
- Ultrasound Diagnosis of Burn Depth
- Ultrasonic Detection of Clear Air Turbulence
- Ultrasonic Temperature Monitor for Hyperthermia

LEWIS RESEARCH CENTER
- Hydrocephalus Shunt--Ventilation
- Texturing for Percutaneous Connectors
- Texturing Surfaces for Cardiovascular Prostheses

MARSHALL SPACE FLIGHT CENTER
- Anatomical Shape Digitization
- Corneal Topography
- Prosthetic Urinary Sphincter

NATIONAL SPACE TECHNOLOGY LABORATORIES
- Wastewater Treatment by Vascular Aquatic Plants

TABLE 2. AGENCIES PARTICIPATING IN RTI TEAM PROJECTS

American Foundation for the Blind
Association for Retarded Citizens
Department of Defense
Department of Transportation
Environmental Protection Agency
Food and Drug Administration
Gerontological Society of America
National Cancer Institute
National Children's Eye Care Foundation
National Eye Institute
National Heart, Lung, and Blood Institute
National Institute on Aging
National Institute of Arthritis, Diabetes, and Digestive and Kidney Diseases
National Institute of Child Health and Human Development
National Institute of Handicapped Research
National Institute of Neurological and Communicative Disorders and Stroke
Paralyzed Veterans of America
U.S. Army Corps of Engineers
U.S. Coast Guard
U.S. Fish and Wildlife Commission
Veterans Administration

TABLE 3. MANUFACTURERS PARTICIPATING IN RTI TEAM PROJECTS

American Hospital Supply	Glendale, CA
Applied Medical Technology, Inc.	Lakewood, OH
B&K Instruments	Cleveland, OH
Becton-Dickinson	Rutherford, NJ
CAMI Health Care, Inc.	League City, TX
Cordis Corporation	Miami, FL
Eagle Engineering Corporation	Houston, TX
Electro-Optics Consultants, Inc.	Huntsville, AL
Everest & Jennings	Los Angeles, CA
Hercules, Inc.	Washington, DC
Heyer Schulte Corporation	Goletka, CA
Intec Systems, Inc.	Pittsburgh, PA
Invacare Corporation	Elyria, OH
Medical Engineering Corporation	Racine, WI
Microwave Associates, Inc.	Burlington, MA
NARCO Bio-Systems, Inc.	Houston, TX
Pacesetter Systems, Inc.	Sylmar, CA
Palm Beach Medical Corporation	E. Long Meadow, MA
Parker-Hannifin Corporation	Irvine, CA
Sonometric Systems, Inc.	New York, NY
Thermo Electron Corporation	Waltham, MA
Wood-Ivey Corporation	Winter Park, FL

Organization	Role
National Aeronautics and Space Administration	Development of advanced technology and innovations
Medical Institutions	Specification of needs and use of medical innovations
Industry	Manufacture and distribution of products
Technology Transfer Teams	Coordination, planning, and reporting
Food and Drug Administration	Approval of products and establishment of medical objectives and priorities

1.4 Report Summary

This annual report is presented in two volumes. The RTI Technology Transfer Team's technical approach to technology transfer is described in Section 2 of both volumes. Section 3 in each volume lists all active transfer projects. Section 4 of Volume I summarizes the team's problemsolving and transfer activities for all active biomedical cases, and Section 4 of Volume II summarizes nonbiomedical activities. Inactivated projects are presented in Section 5 of each volume. Section 6.0 reviews special activities of the RTI team during the reporting period. Section 7.0 presents conclusions and recommendations with emphasis on knowledge gained concerning technology transfer and how this knowledge can enhance the effectiveness of the program. Section 8 lists all travel undertaken for this project during the reporting period.

1.5 References

1. Haggerty, James J. Spinoff 1983. National Aeronautics and Space Administration, Office of External Relations, Technology Utilization and Industry Affairs Division, May 1983.

2. Brown, J. N., Jr., G. E. Morris, and D. J. Rouse. NASA technology applications team program--industrial applications of NASA technology. Research Triangle Institute, Research Triangle Park, NC, June 1983.

2.0 TECHNICAL APPROACH

The technical approach of the RTI Technology Transfer Team is presented in this section. As pointed out in the Introduction, the objective of the RTI Transfer Team is to stimulate the introduction of new and improved commercial products and processes that incorporate NASA-generated technology. Further, these new and improved products and processes are to be introduced in manufacturing, medicine, and rehabilitation.

The methodology of the Technology Transfer Team is illustrated in Figure 1. The figure also illustrates the involvement of participating and responsible organizations for each phase of the program. Each phase of the program is discussed in the following paragraphs with emphasis on illustrating the logical flow of activity from one phase to the next. The primary objective of the methodology is to achieve successful commercialization of a new product or process.

2.1 Identification of Needs and Requirements for Aerospace Technology

The first step in the program is the identification of specific technology-related requirements within an industry. For example, in the machine tool industry, a requirement may be specified that involves a new high-temperature coating for cutting surfaces that will have an increased resistance to wear. In medicine, the requirement may be for high-reliability batteries with high-energy storage capacities to power implantable pacemakers or other physiological prostheses. Requirements and problems in industry are identified by the Technology Transfer Team through discussions, meetings, and seminars with industry, industry associations, and user groups.

2.2 Identification of Potentially Applicable Aerospace Technology

After a complete set of material, device, or system requirements is determined, aerospace technology that represents potential solutions must be identified. This technology can be identified through

- Distribution of complete requirements specifications or problem statements to engineers and scientists in NASA Field Centers or in NASA contract organizations
- Information searches of the aerospace literature
- Direct personal communications with NASA scientists and engineers.

Usually, all three approaches to identifying needed information are used.

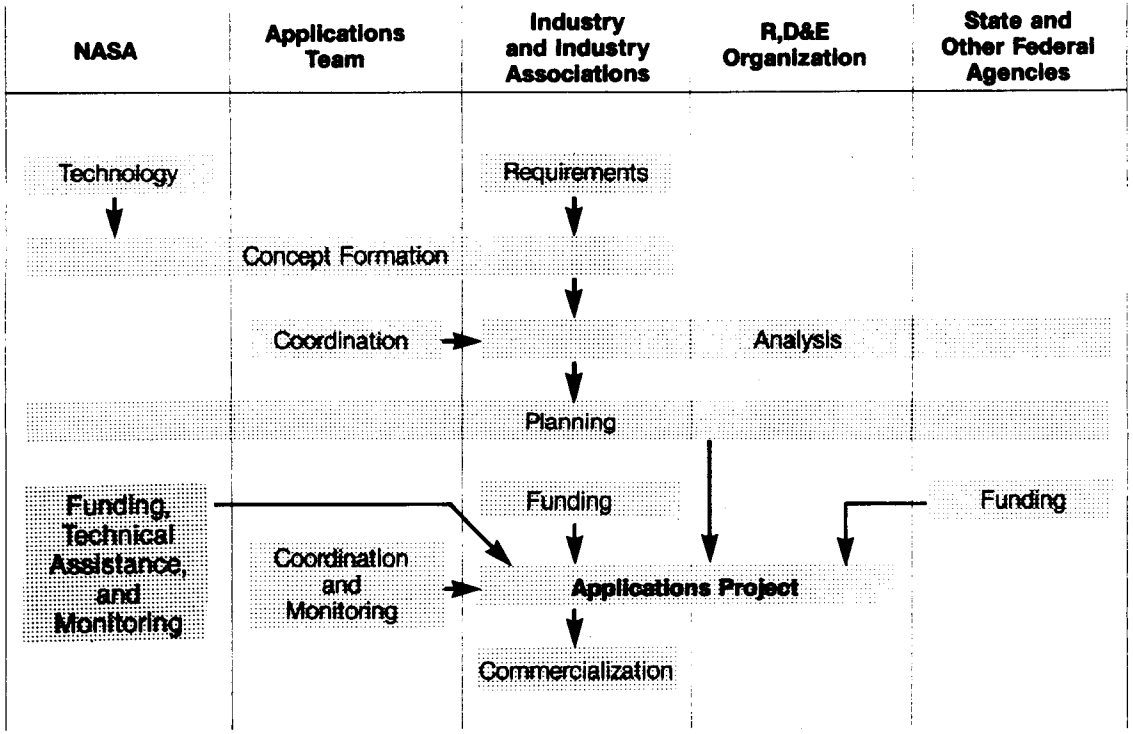


Figure 1. Technology Transfer Team Methodology.

2.3 Product Concept Formation

After a problem or requirement for technology and the corresponding technology have been identified, the information must be integrated into a product (or process) concept. The product concept is formed by NASA and industry scientists and engineers and the Technology Transfer Team. If the technology transfer effort is to continue, aerospace technology must be identified as an essential element of the product concept, the concept must be acceptable to industry, and the resultant product must be marketable.

2.4 Product Concept Analysis

The product concept is next subjected to a detailed analysis to determine if it is technically feasible and if industry can effectively and beneficially use the technology involved. Markets for the product or manufacturing process are estimated to determine the potential impact of the technology transfer opportunity and to assist industry in its decisions to adopt the innovation. Engineering, developmental, and testing procedures are identified. Changes in existing manufacturing processes or in clinical medicine that must occur for utilization to succeed are determined. If appropriate, the analysis includes an initial determination of how to market the innovation if an end product is involved. Finally, analysis involves identifying all organizations and agencies potentially involved.

In some cases, the analysis may be performed by the Technology Transfer Team with information obtained from industry, research organizations, and State and Federal agencies. Usually the analysis can be performed most effectively by an independent group with Government, industry, or the university system.

2.5 Applications Engineering Project Planning

Following analysis of the potential application and approval from NASA to proceed, complete plans for the applications engineering project are developed. Specifications for required reengineering (adaptive engineering), product specifications, and test requirements and procedures that were developed in the analysis phase become part of the applications engineering plan. Any unsolved technical problems and other possible approaches to solving these problems that were identified during analysis are included in the plan. At this point, the organization or organizations that will perform the applications engineering project must be identified, or a method for later selecting that organization must be identified. NASA's participation in the applications engineering project involves technical input and direction from one or more Field Centers, and, in some projects, reengineering or testing by NASA scientists and engineers at a NASA facility. In general, these projects are performed by industry, universities, research institutes, or Federal laboratories.

Schedules and cost estimates for all engineering and development tasks, tests, and procedures must be developed. Sources of funding to cover all costs must be identified and commitments obtained. It is

appropriate for applications engineering to be funded by NASA and other Federal agencies, State agencies, industry, and industry associations. The particular mix of funding sources for any particular project will depend upon the nature of that project and the potential beneficiaries of the end result. The balance between social and private benefits must be considered, with Government's contribution becoming greater as relative social benefits increase. The business profile of the industry must also be taken into account. For example, it is not likely that the small- to medium-sized companies in the footwear industry can contribute the applications engineering costs as can, for example, the semiconductor industry. In cases where the Department of Defense (DOD) can expect to obtain new or improved equipment or cost reductions as a result of technology transfer, then the DOD may find it appropriate to fund part of the applications engineering costs. In the case of the development of medical devices and systems, tests and evaluations are usually funded by industry, the National Institutes of Health, the Veterans Administration, or other Federal agencies.

Both the analysis and planning processes must incorporate input from, or participation by, all organizations that will be involved in or affected by the applications engineering project. Although not indicated in Figure 1, input from users or user representative groups are a very important aspect of analysis and planning. If the product or manufacturing material, machine, or process is subject to Federal or State regulations, then the regulatory agency must be involved. For example, medical devices are subject to Food and Drug Administration regulations, and FDA should have some input to the test and evaluation protocol design.

Finally, the project plan must include provisions for patent applications and for exclusive or nonexclusive licensing. Ownership of relevant patents may reside with NASA, a NASA contractor, or other industry or agency. Licensing arrangements will depend upon ownership, market size, and the generic or product proprietary nature of the innovation. Emphasis on negotiating patent and licensing agreements must balance considerations of industry investment protection and the potential social benefits from the public technology involved.

2.6 Applications Engineering

The fifth step in the process, applications engineering, is the implementation of the project plan produced in the preceding step. Here, the agreements reached in the planning process are implemented. Contracts and subcontracts to perform the engineering and testing are implemented according to the schedule that has been prepared. Funding that has been committed by various organizations and agencies is made available according to the schedule and achievement of milestones.

2.7 Commercialization

The final step is commercialization of the materials, devices, or systems emerging from the applications engineering projects. It is to be expected that if selection of industry, opportunities, and participating

organizations is appropriate, then commercialization will proceed within one or more companies in the industry without further involvement by the Government or program representatives. Program staff will be monitoring the process of commercialization to report the results of the program and to supply information that can improve the overall methodology and operation of the program.

3.0 LIST OF ACTIVE TRANSFER PROJECTS

Anatomical Shape Digitization
Cerebrospinal Fluid (CSF) Control System
Corneal Topography
Digital Data Recorder
High Performance Wheelchair
Hydrocephalus Shunt--Ventilation
Infrasonic Detection of Clear Air Turbulence and Severe Storms
Noninvasive Lung Diagnosis
Portable Cooling System for Quadriplegics
Portable X-Ray Fluorescence Spectrometer (PXRFS) as a Metals Analyzer
Portable X-Ray Fluorescence Spectrometer (PXRFS) for Water Quality Monitoring
Programmable Implantable Medication System
Prosthetic Urinary Sphincter
Texturing for Percutaneous Connectors
Ultrasonic Temperature Monitor for Hyperthermia
Ultrasound Diagnosis of Burn Depth
Wastewater Treatment by Vascular Aquatic Plants
Wildlife Tracking

4.0 STATUS OF ACTIVE TRANSFER PROJECTS--BIOMEDICAL

ANATOMICAL SHAPE DIGITIZATION

RTI Team Personnel: Robert Wallace

Problem

The requirement for orthopedic footwear can result from primary foot disorders such as trauma and biomechanical conditions or may be secondary to systemic diseases such as arthritis, diabetes mellitus, and circulatory disorders.[1] Determination of foot shape is critical in the prescription of orthopedic shoes. Current casting methods are imprecise, slow, require extensive training, and often must be repeated because of fragility of the cast or unacceptable results.[2]

Solution

Technologies developed for gauging shapes, especially for comparison of mass-produced items with a known standard, include contact stylus systems, stereo and moiré photography, holographic imaging, and scanning laser systems. The technology to be used in foot shape digitization should be noncontact, fast, and capable of a resolution of 5 millimeters.

NASA Technology

In response to an RTI problem statement, Marshall Space Flight Center's (MSFC's) Optical Systems Branch proposed the use of a laser scanning system. This technology evolved from NASA research on high speed photodetectors, laser beam modulators, optical systems for the pointing and tracking of laser radiation beams, and optical path length measurement. NASA technology in integrated computer-aided-engineering and design at Langley Research Center will also be utilized in this project.

Principals

Gary H. Hunt, Optical Systems Branch, Marshall Space Flight Center, Huntsville, Alabama.

Cost to NASA

No costs have yet been incurred by NASA. The National Institute of Handicapped Research (NIHR) has issued a contract for $120,000 to develop the criteria for this system.

Commercialization Strategy

A fast, accurate instrument for gauging the shape of irregular three-dimensional objects would be useful in mass production applications. The RTI team has initiated discussions with several manufacturers. Interest in participation has been enthusiastic.

Status

The RTI team and Don Vargo are soliciting cofunding from NIHR and the Veterans Administration (VA). The RTI team continues to define the system requirements in discussions with orthopedic surgeons, podiatrists, and shoe manufacturers.

Action

Don Vargo anticipates the completion of a draft Interagency Agreement between VA and NASA in the next quarter. The RTI team will continue to work with Langley Research Center and MSFC to develop a project plan.

References

1. Port, M. The foot and systemic diseases in the Veterans Administration. J. Am. Pod. Assoc., 70(8):397-403, 1980.

2. Valmassy, R. L. Advantages and disadvantages of various costing techniques. J. Am. Pod. Assoc., 69(12):707-712, 1979.

CEREBROSPINAL FLUID (CSF) CONTROL SYSTEM

RTI Team Personnel: Dr. Doris Rouse

Problem

Hydrocephalus is an excessive accumulation of fluid within the natural cavities of the brain. As the volume of the fluid continues to expand, it does so at the expense of brain tissue so that the untreated hydrocephalic child may suffer severe physical and mental retardation. Current treatment usually involves the surgical insertion of a shunt to divert CSF to another part of the body. An estimated 50 percent of hydrocephalus patients require at least one reoperation to replace or repair a malfunctioning shunt.[1]

Solution

A CSF control system capable of detection and telemetry of data on the pressure and/or volume of the brain ventricle could prevent most shunt failures and the clinical consequences of increased intracranial pressure resulting from those failures.

NASA Technology

NASA technology in microelectronics; command/telemetry systems; and miniaturized, high reliability hydraulic control systems could be used to develop an improved CSF control system.

Principals

Mr. Don Friedman, Technology Utilization Officer, Goddard Space Flight Center.

Cost to NASA

NASA has committed $150,000 to support feasibility studies. Matching cofunding has been committed by the selected feasibility contractors.

Commercialization Strategy

Mr. Don Friedman and the RTI Team have met with two major CSF shunt manufacturers, Heyer Schulte Corporation and Cordis Corporation. Both companies have shown an active interest in the feasibility study and the possibility of follow-on development of the system.

Status

Goddard Space Flight Center (GSFC) conducted a competitive procurement for the feasibility study. Awards were made to three groups: University of Missouri, Applied Physics Laboratory--Johns Hopkins University, and Microelectronics Center of North Carolina/the University of North Carolina. Results of the study are due April 30, 1984.

Action

Feasibility studies will be completed and reviewed by GSFC personnel.

Reference

1. Murtagh, F. R., Quencer, R. M., Poole, C. A. Extracranial complications of cerebrospinal fluid shunt function in childhood hydrocephalus. Am. J. Roentgenol. 135(4):763-766, October 1980.

CORNEAL TOPOGRAPHY

RTI Team Personnel: Dr. H. Clark Beall

Problem

The cornea of the eye is the tough, transparent layer through which light rays must first pass upon entering the eye. Trauma and diseases can distort the spherical surface of the cornea to such an extent that corneal transplant surgery is required to correct the accumulated refractive error. A new surgical procedure, radial keratotomy, is an alternative to corneal transplant surgery. Both procedures require that the surgeon be able to gauge the topography of the corneal surface precisely before, during, and after the surgery.

Solution

Several optical devices are now available that reflect light from the front surface of the cornea. A photographic record can be made of the reflected light pattern; the photo can later be analyzed on an optical bench to quantify, in diopter units, the refractive power of a dozen points on the cornea. An instrument is desired that can gauge in real time the actual contour, or topography, of the corneal surface.

NASA Technology

Two separate items of technology have been proposed by two new research and technology operating plans (RTOPs) in response to the original RTI problem statement. The device proposed by the Jet Propulsion Laboratory (JPL) records and analyzes a moiré image from the corneal front surface. The device proposed by Marshall Space Flight Center employs interferometry. Both systems utilize computer control and data processing.

Principals

Dr. J. Rowsey, surgeon, McGee Eye Institute, Oklahoma City, Oklahoma.
Mr. Don Griner, Marshall Space Flight Center (MSFC), Huntsville, Alabama.
Mr. R. Frazer, Jet Propulsion Laboratory (JPL), Pasadena, California.
Dr. Ralph Helmsen, National Eye Institute, Bethesda, Maryland.
Dr. D. J. Schanzlin, Estelle Doheny Eye Foundation, University of Southern California (USC), Los Angeles, California.

Cost to NASA

JPL has received $139,000 from NASA Headquarters to date for an initial Phase 0 study and subsequent work. MSFC has received $65,000 to date for in-house work and for the recently awarded $48,500 contract to Electro-Optics Consultants, Inc. (EOC), of Huntsville, Alabama. The device will be evaluated by Dr. Rowsey under his current funding from the National Eye Institute.

Commercialization Strategy

There appears to be a ready market for a new generation of gauging devices that could be used during surgery. Contacts have already been made with several manufacturers who could produce such devices.

Status

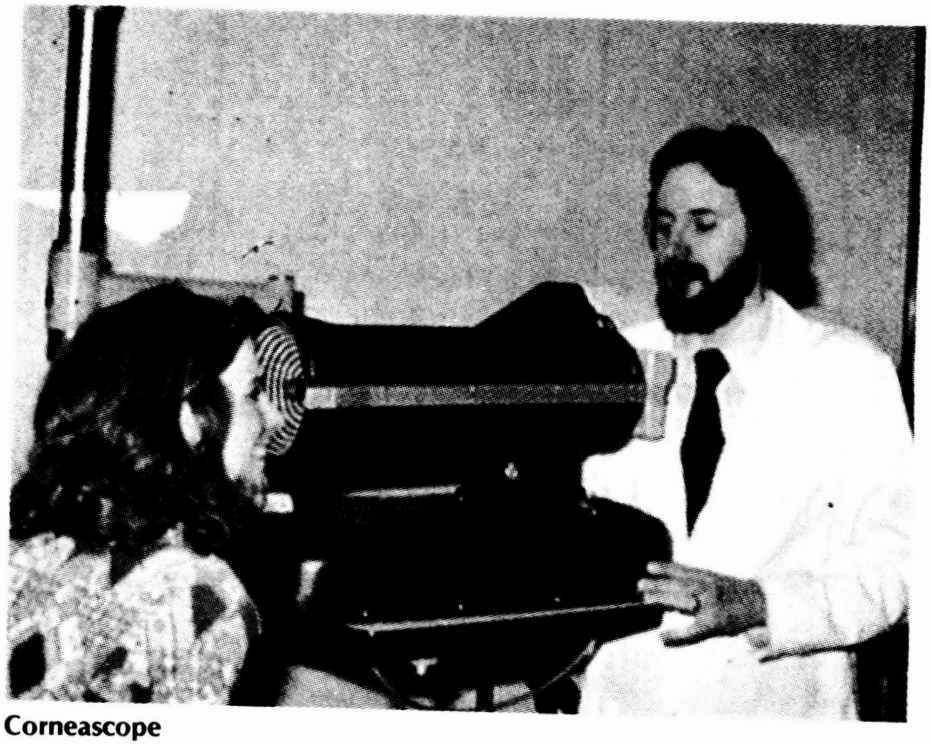
The Phase 0 study at JPL concluded in the first quarter of 1983 with a demonstration of the optical component of the gauging system. JPL has let a cost-sharing contract with Altovac Technology, Inc., for prototype development. MSFC signed a contract with EOC, Inc., on October 7, 1983, for the construction of an interferometric gauge device.

Action

Phase One of the MSFC Project Plan calls for the design and demonstration of a breadboard device in the 24th week of the contract.

CORNEAL TOPOGRAPHY

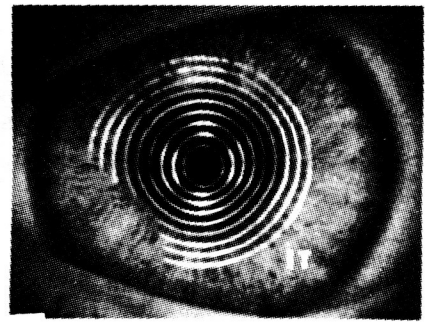
- DISTORTED PLACIDO REFLECTIONS FROM CORNEASCOPE DIFFICULT TO ANALYZE
- NEW SYSTEM NEEDED FOR REAL-TIME GAUGING OF CORNEAL TOPOGRAPHY
- APPROPRIATE NASA TECHNOLOGY:
  - OPTICAL GAUGING
  - DIGITAL IMAGE PROCESSING
  - TV DISPLAY
- McGEE EYE INSTITUTE, OKLAHOMA CITY
  LOS ALAMOS SCIENTIFIC LABORATORY
- NATIONAL EYE INSTITUTE



Corneascope

CORNEAL TOPOGRAPHY

- INSTRUMENT EASILY GAUGES CORNEAL CURVATURE FOR CONTACT LENS
- NEW INSTRUMENT NEEDED FOR REAL-TIME GAUGING OF CORNEAL TOPOGRAPHY
- APPROPRIATE NASA TECHNOLOGY:
  - OPTICAL GAUGING
  - DIGITAL IMAGE PROCESSING
  - TV DISPLAY
- McGEE EYE INSTITUTE, OKLAHOMA CITY
  LOS ALAMOS SCIENTIFIC LABORATORY
- NATIONAL EYE INSTITUTE



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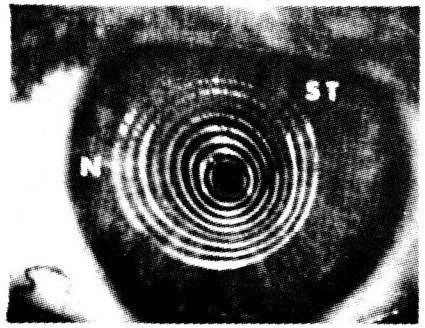

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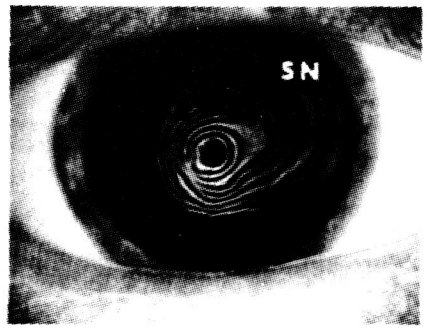


C

Corneascope photographs of tl tages of keratoconus:
A. early B. progressive C. severe.

HIGH PERFORMANCE WHEELCHAIR

RTI Team Personnel: Dr. Doris Rouse

Problem

Approximately 700,000 people in the United States currently rely on wheelchairs for mobility. The limitations of available chairs include heaviness, frequent breakdowns, and limited lifetime, resulting in high life-cycle costs. Recognizing these problems, the Veterans Administration (VA) and the National Institute of Handicapped Research have funded several wheelchair research projects. Most of these projects are component oriented. Few projects involve a full-scale development effort, from analysis of requirements through prototype fabrication and evaluation.

Solution

The use of improved materials as well as computer analysis and simulation could result in an advanced, lightweight wheelchair.

NASA Technology

Structure analysis computer programs used in the design of aerospace vehicles would be useful in the design of an advanced wheelchair. Graphite composite materials developed for aerospace could be incorporated in an advanced chair to reduce weight.

Principals

Mr. Robert Baucom, Materials Applications Branch, NASA Langley Research Center, Hampton, Virginia.
Dr. Colin McLaurin, University of Virginia--Rehabilitation Engineering Center, Charlottesville, Virginia.

Cost to NASA

In 1981, NASA allocated $60,000 to this project. An additional $40,000 will be expended by the University of Virginia Rehabilitation Engineering Center for the design and evaluation of the chair in the first year. Funding for the University of Virginia's participation is provided by the National Institute of Handicapped Research.

Commercialization Strategy

Invacare is very interested in marketing the chair, if the price is reasonable. The RTI team has also discussed participation in this project with several other wheelchair manufacturers. When testing is completed, manufacturers will be invited to Charlottesville for a demonstration and discussion of commercialization.

Status

The initial prototype was built at Langley Research Center. Testing is in progress at the University of Virginia.

Action

The RTI team will work with the University of Virginia and NASA Langley to plan a demonstration for manufacturers.

HYDROCEPHALUS SHUNT--VENTILATION

RTI Team Personnel: Dr. Doris Rouse

Problem

Hydrocephalus is a condition in which the cerebral ventricles enlarge abnormally when the pressure of the cerebrospinal fluid rises. To relieve this pressure, surgeons implant a shunt to drain the excess fluid into other cavities of the body. The shunt frequently fails because the inlet is blocked by an ingrowth of choroid plexus or an accumulation of cellular or fibrin debris.

Solution

A multi-ended inlet catheter, with hundreds of tiny inlets formed by ion-etching techniques, could minimize this problem. The small holes would inhibit tissue ingrowth, and the multiplicity of holes would reduce the possibility of blockage.

NASA Technology

Technology developed in NASA's Ion Propulsion Engine Program is being used to perforate small-diameter catheters.

Principals

Dr. Ed Beckenbach, Jet Propulsion Laboratory (JPL), Pasadena, California.
Mr. Mike Hooven, Cordis Corporation, Miami, Florida.

Cost to NASA

An RTOP totaling $123,000 was submitted in 1978. First-year funding of $41,000 was approved. Another $5,000 was allocated to get the opinions of other medical experts before beginning the second year of the project. A $40,000 feasibility study on 2- to 20-micron pores was conducted by JPL in 1981. NASA allocated $80,000 to continue this JPL effort in 1982.

Commercialization Strategy

The RTI team presented this project to several shunt manufacturers. Discussions with Cordis Corporation resulted in an offer to conduct animal studies at no cost to NASA. A decision to commercialize the shunts will be based on these studies and subsequent clinical trials.

Status

Shunts with 40-μm and 18-μm holes were provided by JPL to Cordis Corporation for animal implants. Initial test results are positive and the tests are continuing under support by the manufacturer.

Action

Evaluation will continue with Cordis. JPL plans to pursue funding for further research on shunt ventilation (geometry, charge).

NONINVASIVE LUNG DIAGNOSIS

RTI Team Personnel: Dr. Doris Rouse

Problem

Disabling pulmonary illnesses may develop as a result of occupational and environmental factors, pulmonary vascular pathology, cystic fibrosis, asthma, or cigarette smoking. Early detection and accurate diagnosis of these illnesses give the treatment a greater chance of success.

Solution

A technique to record and analyze human respiratory sounds would make possible the detection of variations in the caliber of the airways and thus the early detection of pulmonary dysfunction.

NASA Technology

NASA research in aeroacoustics has provided a basis for a theory of the origin of human respiratory sound derived from the motion of vortices in the human lung. This theory has been supported by preliminary tests on lung models by the Medical College of Virginia and Langley Research Center.

Principals

Dr. Jay C. Hardin, Theoretical Acoustics Branch, NASA Langley Research Center, Hampton, Virginia.
Dr. John L. Patterson, Jr., Medical College of Virginia (MCV), Richmond, Virginia.

Cost to NASA

Approximately $61,000 in FY80 and FY81 funds were approved for this project. An FY83 RTOP for $40,000 was submitted. The Medical College of Virginia has allocated $15,000 from the Hundley Fund to support this work. In addition, an NIH Research Career Award supports Dr. Patterson's time on the project at a cost of approximately $30,000/year over a 5-year period. Recently, Dr. Patterson was awarded a Jeffress Research Grant for $79,000 for this project. B&K Instruments, Inc., has already contributed engineering consulting time during several trips to the Medical College of Virginia.

Commercialization Stretegy

B&K Instruments, Inc., has written to John Samos, TUO, Langley Research Center, indicating their interest in this diagnostic system as a commercial product. They predict a market for the system in employee industrial checkup centers as well as in hospitals. B&K and the Medical College of Virginia will continue to collaborate on this project.

Status

Human testing is underway at MCV.

Results of this work have been published in the following:

Hardin, Jay C., and John L. Patterson, Jr. Taking Soundings of the Lungs. Airways, 4(1), 1979.

Hardin, Jay C. Noise Calculation on the Basis of Vortex Flow Models. NASA Tech Brief LAR-12271, Spring 1978.

Hardin, Jay C., and John L. Patterson, Jr. Theory of Sound Generation in the Human Lung. Presented at the Mid-Atlantic Conference on Bio-Fluid Mechanics, Blacksburg, Virginia, August 10-12, 1978.

Hardin, Jay C., and John L. Patterson, Jr. Monitoring the State of the Human Airways by Analysis of Respiratory Sound. ACTA Astronautica, 6(9), September 1979.

Hardin, Jay C., and John L. Patterson, Jr. The Pressure Flow Realation in Bronchial Airways on Expiration. Presented at the Mid-Atlantic Conference on Bio-Fluid Mechanics, Blacksburg, Virginia, May 5-7, 1980.

Hardin, Jay C., and John L. Patterson, Jr. Genesis of Breath Sounds: Theory and Application. Presented at the Fifth International Conference on Lung Sounds, London, England, September 15-16, 1980.

Hardin, Jay C., and John L. Patterson, Jr. Genesis of Breath Sounds: Theory and Application. Presented at the Federation of American Societies for Experimental Biology, 65th Annual Meeting, Atlanta, Georgia, April 12-17, 1981.

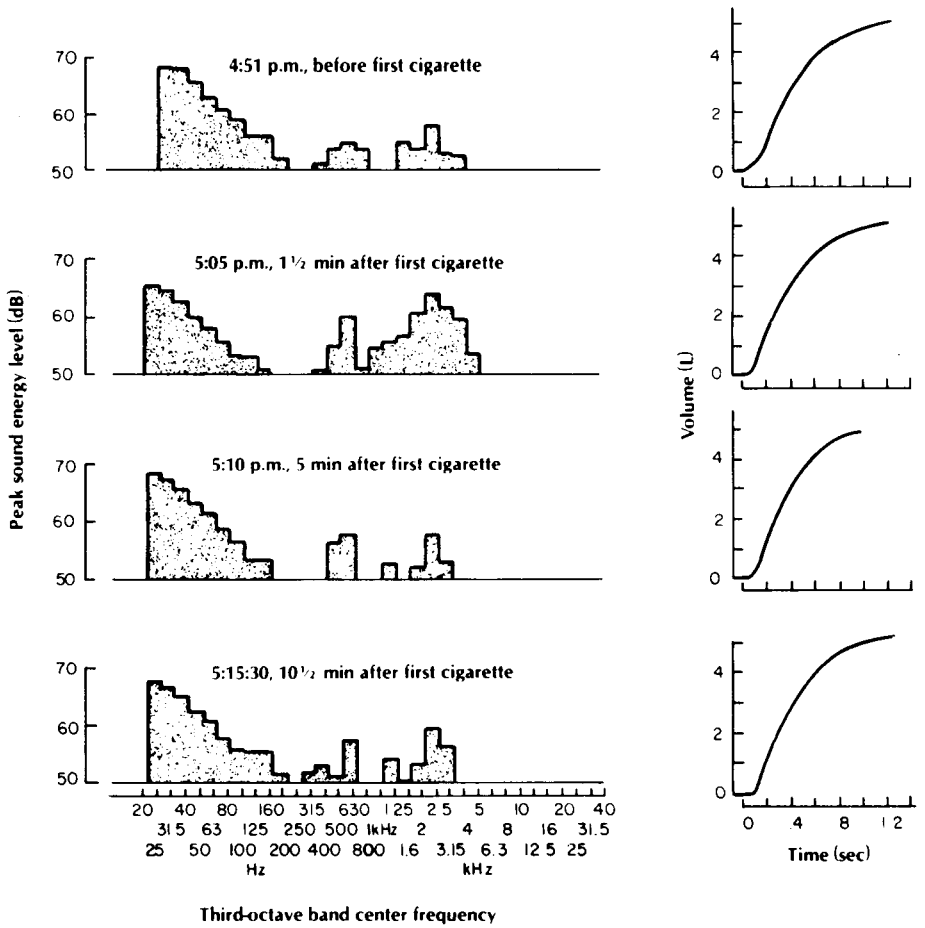
Action

Human testing will continue at MCV.

NONINVASIVE LUNG DIAGNOSIS

- DETECTS PULMONARY DYSFUNCTION BY ANALYZING FREQUENCY AND AMPLITUDE OF LUNG SOUNDS
- RESPONSE TO PHARMACOLOGICAL AND ENVIRONMENTAL STIMULI
- NASA LANGLEY ACOUSTICS TECHNOLOGY
- MEDICAL COLLEGE OF VIRGINIA, RICHMOND

  B & K INSTRUMENTS, INC., CLEVELAND, OH



Spectral phonopulmonograph of a 27-year-old white male showing forced exhalation before smoking and 1½, 5, and 10½ minutes after smoking one cigarette.

PORTABLE COOLING SYSTEM FOR QUADRIPLEGICS

BATeam Personnel: Dr. Doris Rouse

Problem

Quadriplegics are vulnerable to heat stress because they cannot perspire below the level of injury, a condition that results from the interruption of autonomic neural pathways that mediate thermoregulatory perspiration and vasomotion. Quadriplegics exposed to even moderately high temperatures risk hyperventilation, increased heart rate, and heat stroke.

Solution

A portable cooling garment would eliminate these risks, thus opening new employment and daily living opportunities for individuals previously confined to temperature-controlled environments.

NASA Technology

Technology from the development of thermal control garments to protect astronauts has been used to make a water-cooled vest for quadriplegics.

Principals

Ms. Pat Kirk, Environmental Control Research Branch, NASA Ames Research Center, Moffett Field, California.

Dr. Inder Perkash, Spinal Cord Injury Unit, Veterans Administration Medical Center, Palo Alto, California.

Dr. Richard Bruno, Department of Rehabilitation Medicine, Columbia University School of Medicine, New York, New York.

Cost to NASA

Fabrication of prototype vest systems for evaluation by VA Palo Alto cost NASA $15,000. The in-kind cost to the VA Palo Alto for the evaluation at VA Palo Alto will be approximately $15,000.

Commercialization Strategy

Palm Beach Medical Corporation, who has expressed an interest in marketing the quadriplegic cooling vest, is following the evaluation. Other manufacturers will be contacted as well.

Status

Personnel at Ames Research Center designed a small water-cooling and pumping unit for use with the vest. An informal evaluation of the system by a quadriplegic indicated that the system was quite effective. The VA Medical Center in Palo Alto has prepared a protocol for evaluation of the vest in the NASA Ames environmental chambers and in outpatient use. Columbia University researchers have visited Ames and plan to evaluate the system with spinal cord injury patients.

Action

The RTI team will monitor the VA and Columbia evaluations and continue commercialization efforts.

PORTABLE COOLING SYSTEM FOR QUADRIPLEGICS

- QUADRIPLEGICS UNABLE TO PERSPIRE BELOW LEVEL OF INJURY. VULNERABLE TO HEAT STRESS
- NASA THERMAL CONTROL TECHNOLOGY
- COOLING VEST AND PUMPING/CHILLING UNIT
- SPINAL CORD INJURY UNIT, VA MEDICAL CENTER, PALO ALTO, CA

  DEPARTMENT OF REHABILITATION MEDICINE
  COLUMBIA UNIVERSITY SCHOOL OF MEDICINE

Portable cooling system. A = reservoir, B = battery, C = pump.

PORTABLE COOLING SYSTEM FOR QUADRIPLEGICS

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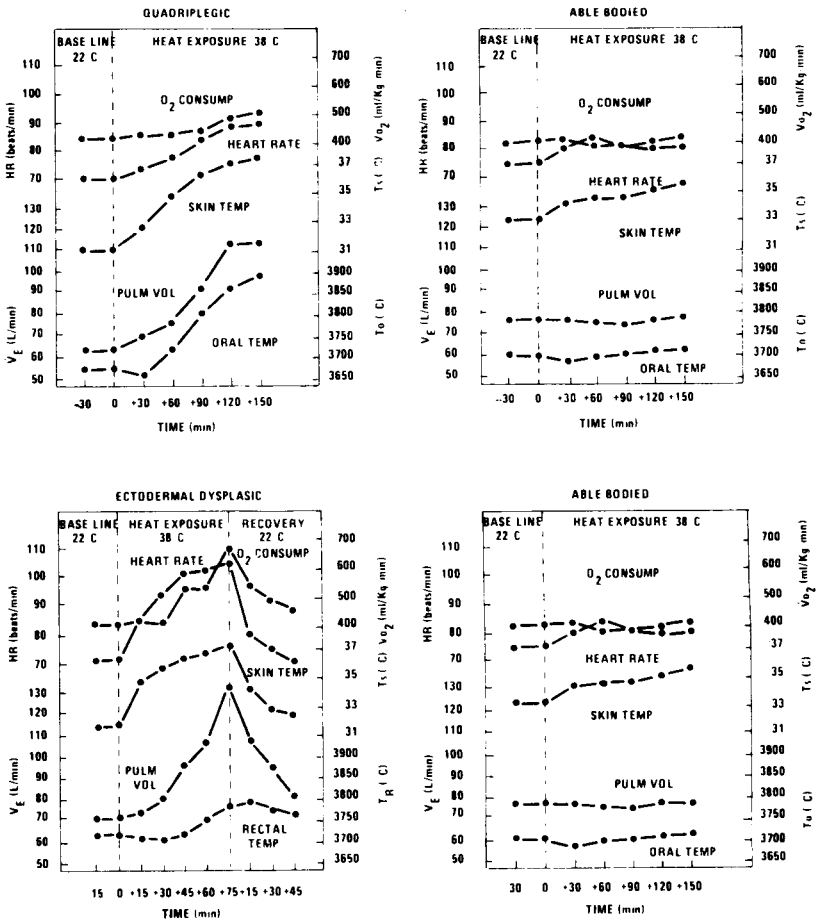

From G. L. Totel, "Physiological Responses to Heat of Resting Man with Impaired Sweating Capacity," *J. Appl. Physiol. 37,* 1974, p. 346.

PROGRAMMABLE IMPLANTABLE MEDICATION SYSTEM

RTI Team Personnel: Dr. Doris Rouse

Problem

A number of chronic diseases require long-term infusion or frequent injections of medication. An implanted pump has been used for the continuous, intravenous infusion of heparin in patients for more than 24 months. One million diabetics in the United States depend on daily insulin injections to help control blood sugar levels; one in ten of these is a child.[1] A programmable implantable pump capable of several delivery rates would be extremely useful in the infusion of insulin to treat diabetes. A more reliable control of blood sugar levels throughout a diabetic's life is thought to diminish the incidence of the complications associated with diabetes--kidney disease, diabetic retinopathy, atherosclerosis, and heart attacks.[2] [3] [4]

The conventional treatment for controlling blood sugar levels in the diabetic requires two to four insulin injections daily. In addition, the patient must accept significant lifestyle and diet restrictions. Despite these efforts, however, true normalization of blood glucose is rare, because of changes in daily activity levels, changes in diet, and shortcomings in the insulin delivery system.

Plasma glucose concentration in healthy subjects remains between 70 and 120 mg/dL over a 24-hour period.[4] In contrast, a patient with juvenile-onset diabetes, who is taking multiple, daily insulin injections, will still have a hyperglycemic plasma glucose concentration of more than 200 mg/dL. The diabetic may also experience periodic hypoglycemia (plasma glucose less than 50 mg/dL).[5] Tamborlane et al. recently reported that good plasma glucose control could be obtained in juvenile diabetes patients by the use of a portable insulin infusion system that delivers a basal rate of insulin with a preprandial pulse.[6] An implantable infusion system that could achieve the plasma glucose control demonstrated in this external system would have obvious advantages.

Solution

An implantable infusion pump that could accurately deliver medication at programmed rates would have great potential in the treatment of several diseases including diabetes, leukemia, thalassemia, and hormone disorders. Safety features and reliable delivery rates would be required to insure safe medication levels.

NASA Technology

The programmable implantable medication system (PIMS) will incorporate NASA technology in three areas: (1) microminiaturized hybrid circuitry will be used for the pump system as well as the programming unit, (2) the programming unit will use command and telemetry systems with functions similar to those used on small astronomy satellites and other spacecraft, and (3) aerospace technology in

miniature, highly reliable hydraulic control systems will be used in the medication delivery portion of the system.

Principals

Mr. Don Friedman, Technology Utilization Officer, Goddard Space Flight Center.
Mr. Robert Fischell, Applied Physics Laboratory, Johns Hopkins University, Laurel, Maryland.
Mr. Al Mann, Pacesetter Systems, Inc., Sylmar, California.
Mr. Steve Wirtz, Parker-Hannifin/Biomedical Products Division, Irvine, California.
Dr. Christopher Saudek, Johns Hopkins University, Baltimore, Maryland.

Cost to NASA

NASA FY80: $216K; FY81: $575K; FY82: $410; FY83: $328.

National Institute of Child Health and Human Development (NICHHD)	$ 400,000
Wilson-Greatbach Limited	500,000
National Institute of Arthritis, Diabetes, and Digestive and Kidney Diseases (NIADDKD)	2,500,000
Pacesetter Systems, Inc.	2,000,000
Parker-Hannifin, Inc.	3,000,000
Applied Physics Lab (APL)	50,000
Baker Foundation	2,500
NOVO	2,000,000
Total cost sharing	$10,452,500

Commercialization Strategy

Pacesetter Systems and Parker-Hannifin plan to manufacture and market the PIMS.

Status

The second phase of the animal trials, long-term implants, is underway at Johns Hopkins. Results thus far are very good. The project team is currently awaiting approval from FDA for the first human implant for infusion of pain-relief medication.

Action

Long-term animal studies will continue. FDA action on the human implant request is expected by April 1984.

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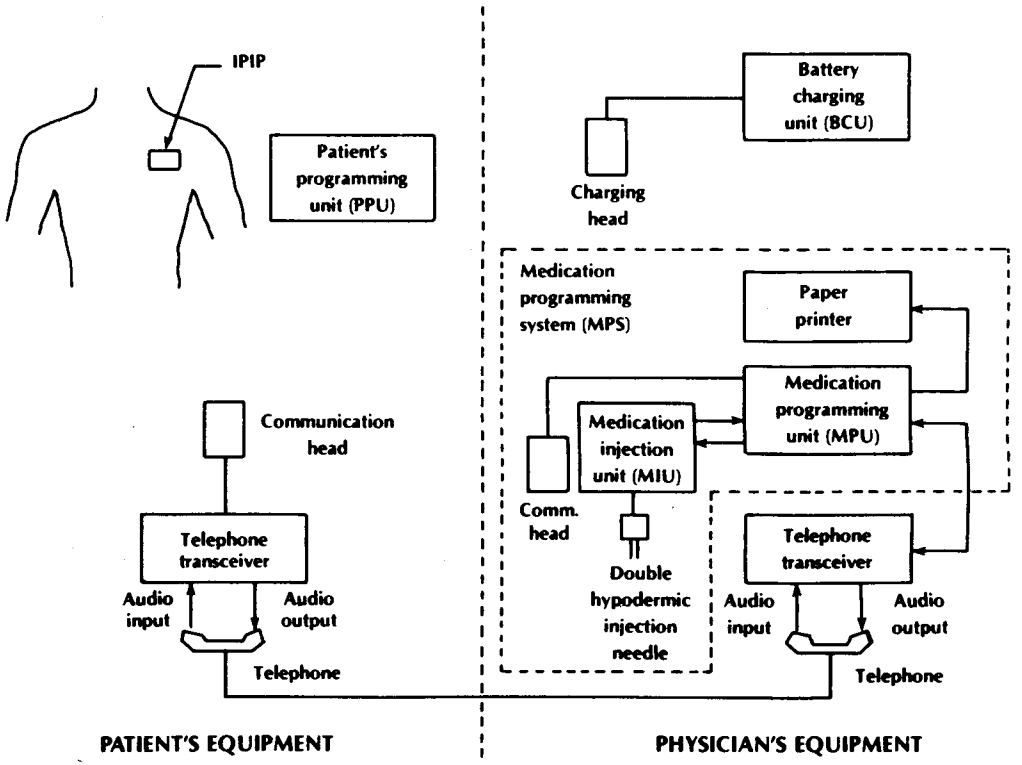
3. Siperstein, M.D. New England Journal of Medicine, 296:1060, 1977.
4. Service, F. J., et al. Diabetes, 19:644, 1970.
5. Molnar, G. D., Taylor, F. W., and A. L. Langworthy. Mayo Clinical Proceedings, 47:709-719, 1972.
6. Tamborlane, W. V., et al. New England Journal of Medicine, 300(11):573-578, March 15, 1979.

PROGRAMMABLE IMPLANTABLE MEDICATION SYSTEM

- ACCURATE DELIVERY OF MEDICATION AT PROGRAMMED RATES
- USE IN TREATMENT OF CHRONIC DISEASES SUCH AS DIABETES
- NASA COMMAND AND TELEMETRY SYSTEMS
- NASA VALVE TECHNOLOGY
- APPLIED PHYSICS LABORATORY, LAUREL, MD
  PACESETTER SYSTEMS, INC., SYLMAR, CA
  PARKER-HANNIFIN, IRVINE, CA
  JOHNS HOPKINS UNIVERSITY, BALTIMORE, MD



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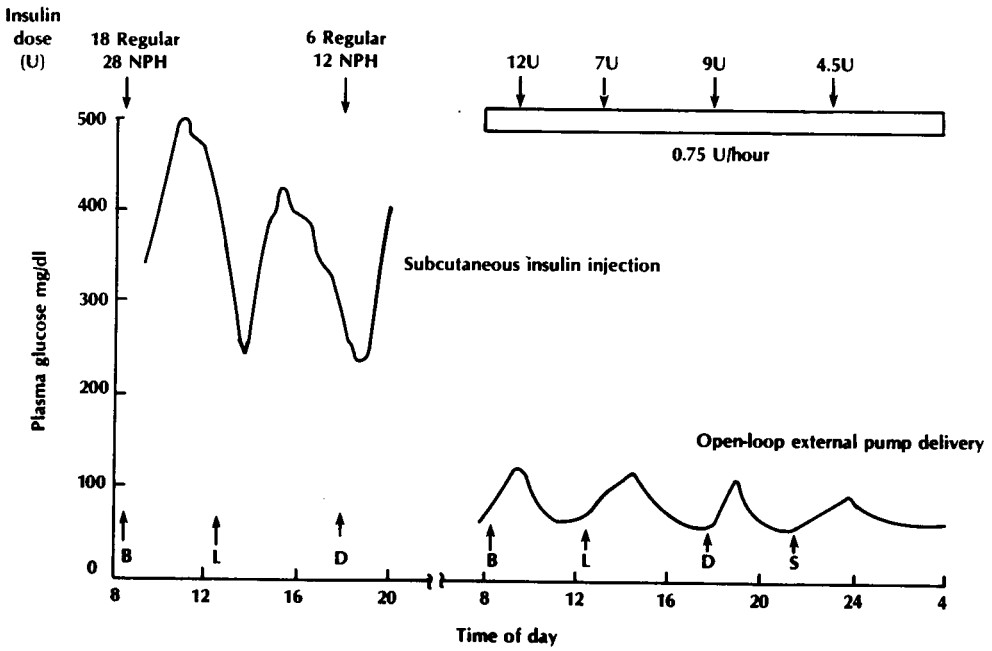


B = Breakfast
L = Lunch
D = Dinner
S = Snack
NPH = Neutral Protein Hagedorn = Isophane Insulin

From Clarke et al., *The Journal of Pediatrics*, October 1977 and Tamborlane et al., *NEJM*, March 15, 1979.

PROSTHETIC URINARY SPHINCTER

RTI Team Personnel: Dr. Doris Rouse

Problem

A malfunctioning urethral sphincter is often responsible for the inability to control emptying of the bladder. This condition may result from congenital, traumatic, postsurgical, or neurogenic disorders. Continence can sometimes be restored by an implanted device that occludes the urethra and allows voluntary voiding by manual release of the occluding pressure. Two factors currently prevent widespread acceptance of such devices by the medical community: (1) the surgical complexity of the implantation procedure and (2) a high rate of device malfunction, often the result of valve failure.

Solution

A simpler, more reliable system is needed for occluding the urethra.

NASA Technology

The low-pressure, "zero" leakage, high-reliability valves used in the Viking project have been adapted for use in a prosthetic urinary sphincter.

Principals

Mr. John B. Tenney, Department of Surgery, Rochester General Hospital, Rochester, New York.
Mr. Steven Wirtz, Parker-Hannifin Corporation, Irvine, California.
Mr. Dave Sanders, President, Medical Engineering Corporation, Racine, Wisconsin.

Cost to NASA

NASA's total cost was $203,000. Parker-Hannifin Corporation has invested $250,000. Medical Engineering Corporation (MEC), a division of Bristol Meyers, has invested $250,000. In-kind contributions by Rochester General Hospital (RGH) have totaled $25,000.

Commercialization Strategy

MEC will market and distribute the system worldwide. Parker-Hannifin will supply the hydraulic control portion of the system. MEC and Parker-Hannifin are currently developing two other medical devices that utilize the NASA valve developed by Parker-Hannifin, a penile prosthesis and a continent colostomy device.

Status

Animal trials have been completed at Rochester General Hospital. Results of these trials and extensive life cycle testing for reliability have been excellent. MEC has filed a Premarket Notification with the Food and Drug Administration.

Action

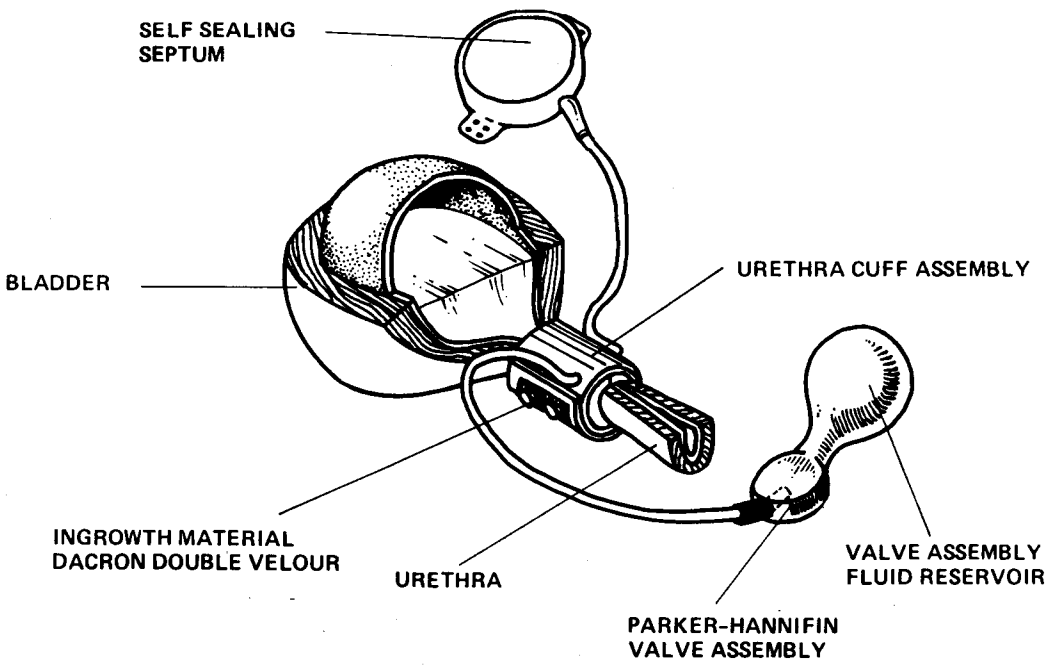
Clinical trials are planned for the summer of 1984.

PROSTHETIC URINARY SPHINCTER

- 2%-5% OF POPULATION SUFFERS URINARY INCONTINENCE
- NASA TECHNOLOGY IN MINIATURIZED, HIGHLY RELIABLE VALVE SYSTEMS
- ROCHESTER GENERAL HOSPITAL DEPARTMENT OF SURGERY

  PARKER-HANNIFIN, IRVINE, CA

  MEDICAL ENGINEERING CORPORATION, RACINE, WI



NASA press/relieve valve concept of prosthetic urinary sphincter

PROSTHETIC URINARY SPHINCTER

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- NASA TECHNOLOGY IN MINIATURIZED, HIGHLY RELIABLE VALVE SYSTEMS
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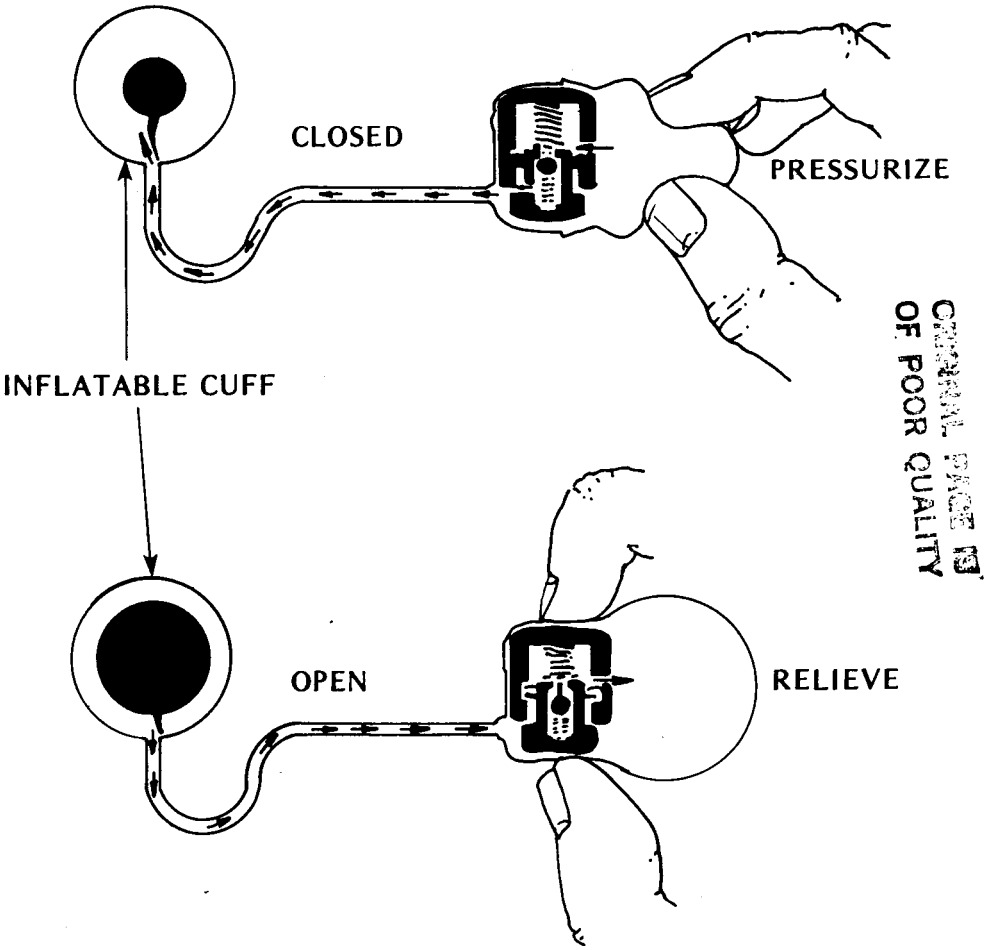
- PARKER-HANNIFIN, IRVINE, CA
- MEDICAL ENGINEERING CORPORATION, RACINE, WI



NASA press/relieve valve concept of prosthetic urinary sphincter

TEXTURING FOR PERCUTANEOUS CONNECTORS

RTI Team Personnel: Dr. Doris Rouse

Problem

Percutaneous connectors are conduits through the skin that facilitate the transmission of fluids or connecting devices between the external environment and the body's internal milieu. Current percutaneous connectors are unacceptable for long-term implants because of externalization and infection.

Solution

If percutaneous connectors could be developed with a reduced tendency to externalize and with an improved body fluid seal to inhibit bacterial invasion, morbidity could be greatly reduced and new device applications could be explored.

NASA Technology

NASA electron propulsion technology may be used to ion-beam texture percutaneous connectors to prevent externalization and reduce infection.

Principals

Mr. Sandy Felder, NASA Lewis Research Center, Cleveland, Ohio.
Dr. George Picha, President, Applied Medical Technology, Inc., Lakewood, Ohio.

Cost to NASA

An FY80 RTOP was submitted for $155,000 over a 3-year period. Cost sharing by the potential manufacturer will be $252,000 over 4 years.

Commercialization Strategy

A NASA patent disclosure has been filed. Applied Medical Technology, Inc., plans to market textured connectors if the study proves successful. American Hospital Supply (AHS) Corporation is interested in collaborating with Applied Medical Technology to commercialize several devices using NASA's ion-texturing.

Status

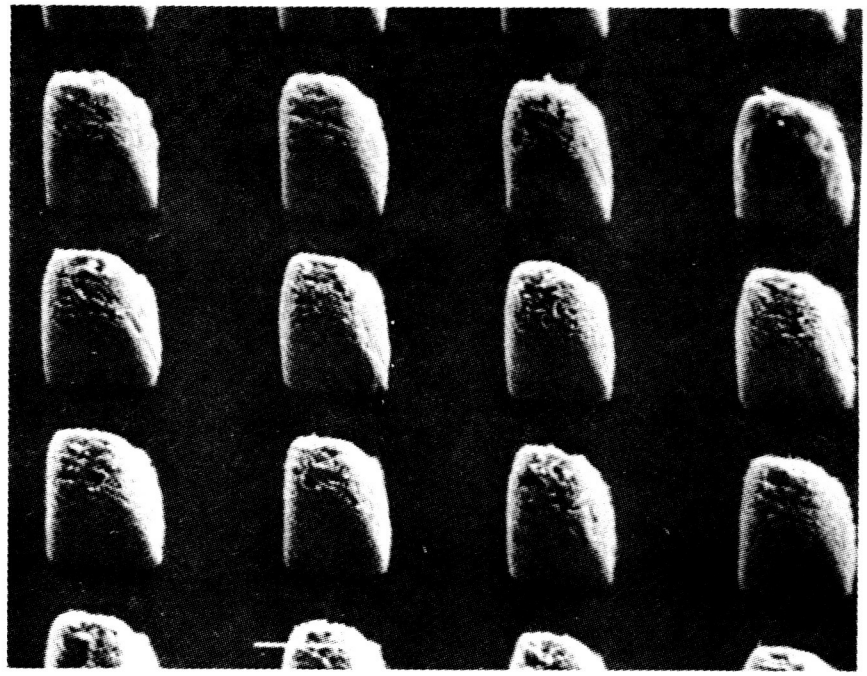
In December 1983, NASA, American Hospital Supply, and Applied Medical Technology, Inc., began a collaborative project to complete development and test ion-textured percutaneous connectors. Vitreous carbon connectors will be ion-textured and coated to reduce externalization.

Action

The collaborative development and testing effort will continue for 1 year.

PERCUTANEOUS CONNECTORS

- PREVENT INFECTION AND REJECTION OF THROUGH-THE-SKIN CONDUITS
- TEXTURE SURFACE OF CONDUIT MATERIAL FOR TISSUE ATTACHMENT
- NASA-LEWIS ION-BEAM TECHNOLOGY
- APPLIED MEDICAL TECHNOLOGY, INC. CLEVELAND, OH



Scanning electron micrograph of ion-beam textured surface

ULTRASONIC TEMPERATURE MONITOR FOR HYPERTHERMIA

RTI Team Personnel: Dr. H. Clark Beall

Problem

The treatment of cancer by localized hyperthermia is a procedure receiving progressively more attention by oncologists. The generation of hyperthermia at localized sites within the human body can be accomplished by ultrasound irradiation, microwave irradiation, or radiofrequency irradiation. The significant technical hindrance to the therapy is the requirement for knowledge of the precise temperature at the hyperthermia site within the body. Reports in the hyperthermia literature indicate that both the exact temperature and the duration of application must be monitored and controlled during hyperthermia sessions.

Solution

NASA Headquarters assigned Langley Research Center the responsibility of devising a procedure for the remote measurement of the temperature within the human body. Initial tests at Langley had shown that passive microwave sensing of temperature was not precise enough, or localized enough, to be useful during hyperthermia.

NASA Technology

A meeting at the Langley Technology Utilization Office of NASA scientists and an RTI Technology Transfer Team representative resulted in the derivation of several theoretical techniques for measurement of temperature by remote means. The most feasible and most novel method involves the use of ultrasound for the detection of phase transitions within strategically located deposits of organic crystalline material within or near the hyperthermia site.

Principals

Joe Heyman, Ph.D., NASA Langley Research Center, Hampton, Virginia
Dr. Thomas Cetas, University of Arizona, Tucson, Arizona.

Cost to NASA

$94,000 has been approved through FY84. Evaluation of the system is being cofunded by the National Institutes of Health through the University of Arizona.

Commercialization Strategy

The eventual result of the effort for hyperthermia thermography is the development of an optimized ultrasound scanning system and a set of specially formulated fat compounds with sharply defined melting points. This custom apparatus should be of commercial value to manufacturers of ultrasound and hyperthermia equipment. A major ultrasound device manufacturer has expressed an interest in the device.

Status

As a result of RTI Team discussions with the National Cancer Institute (NCI), a collaboration was established between Dr. Heyman (Langley) and Dr. Cetas of the University of Arizona. Dr. Cetas is funded by NCI to evaluate hyperthermia techniques. Testing of phase implants has begun at Langley with tissue artifacts.

Action

Successful laboratory testing of the system at Langley will be followed by animal trials at the University of Arizona.

ULTRASOUND DIAGNOSIS OF BURN DEPTH

RTI Team Personnel: Dr. Doris Rouse

Problem

Approximately 2 million Americans suffer serious burns each year, and 200 to 300 thousand of these people require hospital treatment.[1] Among those hospitalized, 70,000 receive intensive care and 10 to 12 thousand patients die from their injuries. The cost of intensive care exceeds $300 million per year.[2] The traditional treatment of burn victims is to allow natural debridement, sloughing of necrotic tissue, to occur and then to close the resulting open wounds with skin grafts. Unfortunately, the weeks required for spontaneous sloughing often result in infection and sepsis; indeed, the major cause of death in burn victims is bacterial infection.[3] Modern treatment, therefore, is based on early recognition and removal of necrotic tissue to reduce infection and hasten healing. This surgical or chemical debridement depends upon accurate burn depth information for optimal results. Current methods for burn depth determination are inaccurate, cumbersome, or both.

Solution

Ultrasound may be used to map precisely and conveniently the depths of the interface between viable and necrotic tissue in burn injuries. Preliminary studies in pigs demonstrate a good correlation between depths of burn measured by pulse-echo ultrasound and by histological techniques.

NASA Technology

Advanced ultrasonic technology developed at Langley Research Center for the characterization of materials is directly applicable to this project.

Principals

Mr. David Stein, Sonometric Systems, Inc., New York, New York.
Dr. John H. Cantrell, Jr., Langley Research Center, Hampton, Virginia.
Dr. Tom Yost, Langley Research Center, Hampton, Virginia.
Col. Basil Pruitt, Jr., M.D., U.S. Army Institute of Surgical Research (USAISR), Ft. Sam Houston, Texas.
Dr. Boyd Haynes, Jr., Director, Burn Unit, Medical College of Virginia (MCV), Richmond, Virginia.

Cost to NASA

Estimated cost for development of the prototype is $146,000. Estimated cost to the Army and MCV for evaluation of the device is $210,000 in the first year. Sonometric Systems will provide engineering support estimated at $50,000 in FY84.

Commercialization Status

The RTI team has contacted 15 manufacturers of medical ultrasound devices. In response, Sonometric Systems, Inc., prepared a proposal for collaboration with NASA and subsequent marketing of the system.

Status

Langley researchers have been working with Sonometrics in the design of the burn depth analyzer. Transducer testing has been completed. Langley researchers presented an invited paper on this system at a conference sponsored by the National Institutes of Health, the World Health Organization, and the International Society for Burn Injuries on September 26, 1983. A paper based on this presentation will be published in the Journal of Trauma.

Action

Completion of the system is expected in the first quarter of 1984. Laboratory testing will be followed by initial clinical trials at MCV by June 1984.

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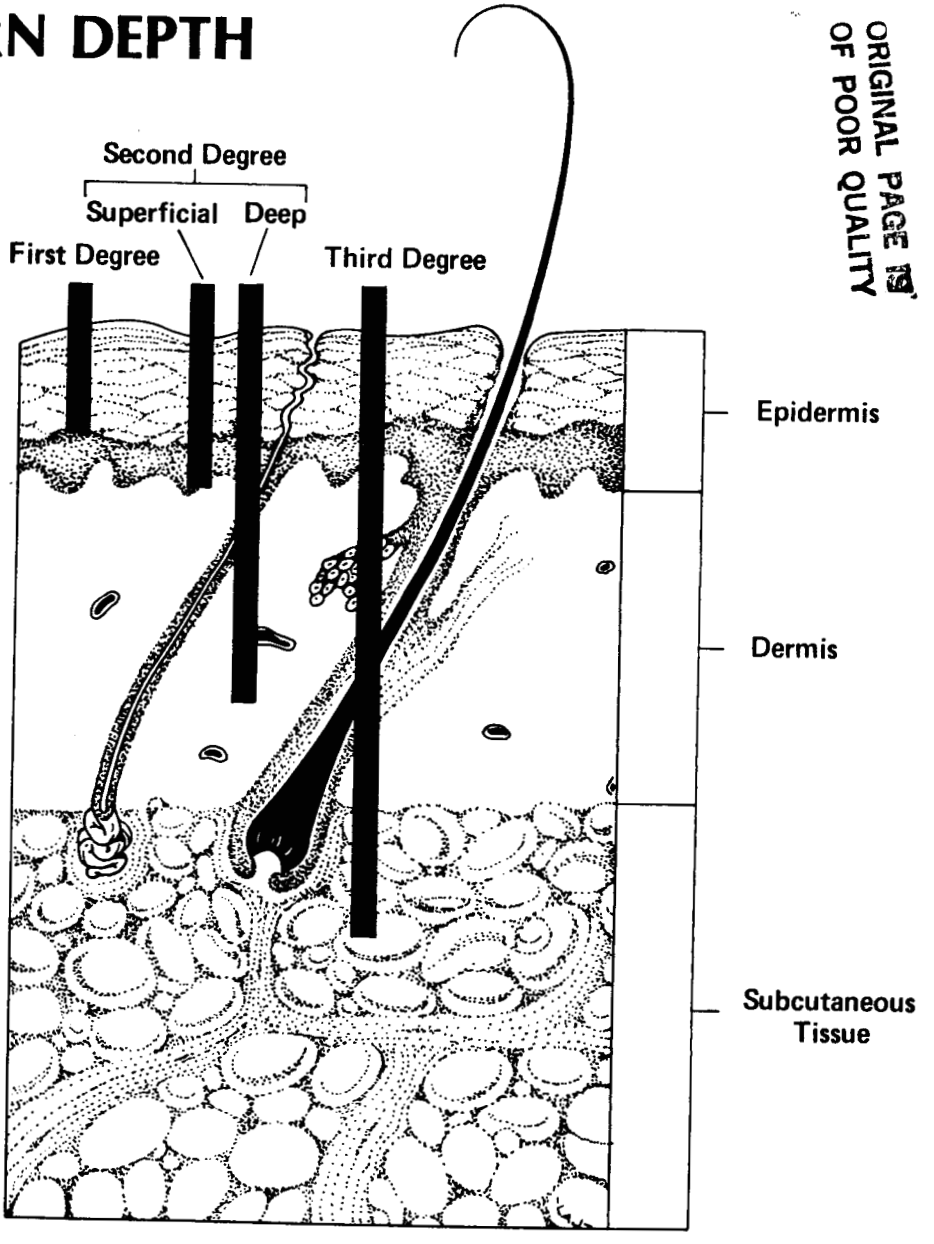
ULTRASOUND DIAGNOSIS OF BURN DEPTH

- 2 MILLION SERIOUS BURNS EACH YEAR IN U.S.
- NASA TECHNOLOGY IN ULTRASOUND CHARACTERIZATION OF MATERIALS
- U.S. ARMY INSTITUTE OF SURGICAL RESEARCH, FT. SAM HOUSTON, TX
- MEDICAL COLLEGE OF VIRGINIA, RICHMOND, VA

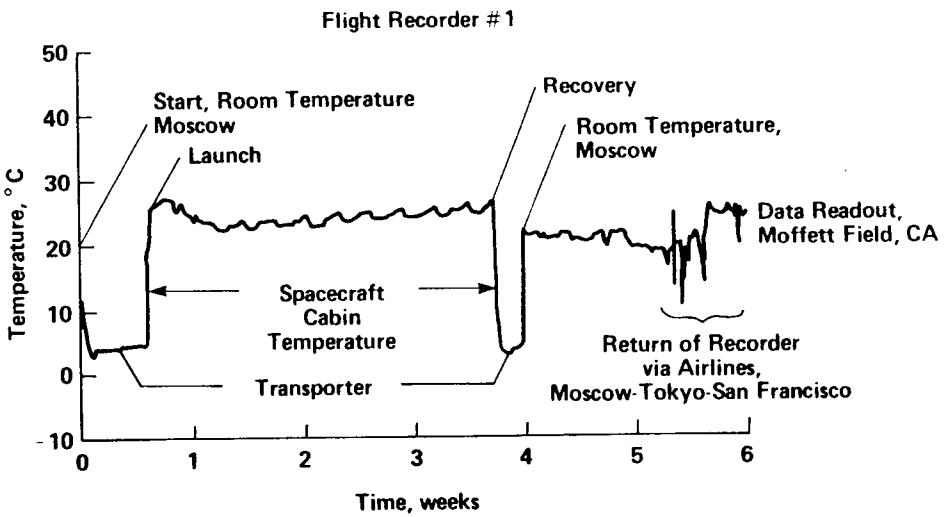
  SONOMETRIC SYSTEMS, NEW YORK, NY



Source: *Treatment of Burns.* Yang Chih-chun, Hsu Wei-shia, and Shih Tsi-siang, eds. Springer Verlag, New York, 1982.

DIGITAL DATA RECORDER FOR PHYSIOLOGICAL MONITORING

- RECORDING OF PHYSIOLOGICAL PARAMETERS DURING SLEEP
- TEMPERATURE DATA RECORDER DEVELOPED BY NASA AMES RESEARCH CENTER FOR SHUTTLE FLIGHTS
- LIGHT-WEIGHT, SMALL RECORDER WITH NO ATTENDANCE REQUIREMENT
- WALTER REED INSTITUTE OF MEDICAL RESEARCH
  ALBERT EINSTEIN COLLEGE OF MEDICINE



Data from US-USSR Cosmos satellite flights

4.0 STATUS OF ACTIVE TRANSFER PROJECTS--NONBIOMEDICAL

DIGITAL DATA RECORDER

RTI Team Personnel: Dr. H. Clark Beall

Problem

There are approximately 20 million insomnia sufferers in the United States. By conservative estimates, 40 percent of people over 60 years of age have "sleep apnea," an inadequate blood oxygen level due to a temporary irregularity of respiration. The apnea episodes cause recurrent awakenings during sleep at night. The resultant lack of restful sleep causes confusion, drowsiness, irritability, and lack of attention during daylight hours. This is especially a problem in the elderly. Researchers who wish to study the psychology and physiology of sleep have traditionally brought patients to the laboratory where sophisticated instrumentation can record the physiological changes that occur during the various sleep stages. They have found, however, that the laboratory environment affects the sleep patterns of most patients. What is required is a means of recording physiological data in the home environment to reduce costs and improve data quality.

Principals

Dr. Elliot D. Weitzman, Montefiore Hospital and Medical Center, Bronx, New York.
Dr. Fred Hegge, Walter Reed Army Medical R&D Command, Washington, DC.

Solution

Most sleep researchers record data on multipen strip chart recorders. These recorders are quite expensive and not at all portable. Improved sleep monitoring requires a new system of battery-operated, solid-state, small digital data recorders that can be distributed to patients for use at home and returned to the laboratory for readout of the data.

NASA Technology

NASA TM-81267[1] describes a digital, solid-state recorder that features a self-contained battery, CMOS circuitry, a 2048-word digital memory, an 8-bit analog-to-digital converter, and an operating capability of several weeks. Although the device is used in the NASA Space Shuttle as a temperature recorder, the temperature transducer could be replaced with other transducers appropriate for measuring parameters such as respiration rate, movement, muscle activity, eye movement, and body temperature.

Cost to NASA

No cost to NASA is anticipated for the biomedical application of this device.

Commercialization Strategy

Descriptive literature has been mailed to 10 prospective manufacturers following phone inquiries by the Team.

Status

The digital recorder is a mature technology that can be applied to temperature sensing and logging in industry and manufacture as well as in physiological monitoring. To explore the industrial application of the device, the Technology Transfer Team contacted eight prospective manufacturers by phone, and all eight requested additional information. These companies are currently manufacturing industrial temperature measurement and charting devices.

Action

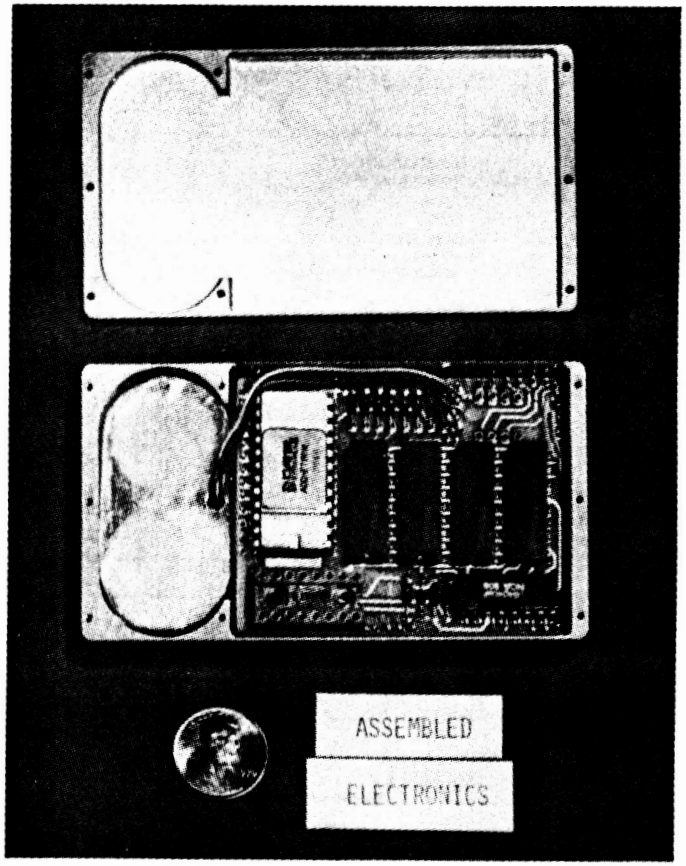
Approximately seven additional companies have been identified as prospective manufacturers of the data recorder for industrial temperature logging applications. These companies will be contacted in the near future.

Reference

1. Westbrook, R. M., L. D. Bennett, R. A. Steinhauer, and G. J. Deboo. A Solid-State Digital Temperature Recorder for Space Use. NASA TM-81267, NASA Ames Research Center, 1981.

DIGITAL DATA RECORDER FOR PHYSIOLOGICAL MONITORING

- RECORDING OF PHYSIOLOGICAL PARAMETERS DURING SLEEP
- TEMPERATURE DATA RECORDER DEVELOPED BY NASA AMES RESEARCH CENTER FOR SHUTTLE FLIGHTS
- LIGHT-WEIGHT, SMALL RECORDER WITH NO ATTENDANCE REQUIREMENT
- WALTER REED INSTITUTE OF MEDICAL RESEARCH
  ALBERT EINSTEIN COLLEGE OF MEDICINE



Recorder with cover removed

INFRASONIC DETECTION OF CLEAR AIR TURBULENCE AND SEVERE STORMS

RTI Team Personnel: Bernard Maggin

Problem

Although improved reporting and forecasting have greatly reduced the adverse impact of weather on aircraft operations, unfavorable weather is still the principal factor in a majority of approach and landing accidents. Technology is needed to (1) predict hazards for aircraft operations and (2) define hazards to enable redesign of future aircraft for hazard avoidance.

Solution

A system capable of detecting clear air turbulence and severe storms using naturally occurring infrasound (0.05 to 10 Hz) in the earth's atmosphere would supplement current radar observation methods.

NASA Technology

NASA's Transport Technology Program in the Office of Aeronautics and Space Technology (OAST) has developed a microphone array system and software for detection and analysis of infrasound signals.

Principal

Dr. Allan J. Zuckerwar, Langley Research Center, Hampton, Virginia.

Cost to NASA

FY83 funds totalled $30,000.

Commercialization Strategy

The technology is intended for transfer to the Federal Aviation Agency (FAA) for evaluation. Solicitation of manufacturer interest will be pursued after adoption of the system by FAA.

Status

Dr. Zuckerwar and Mr. Maggin met with Dr. Tobiason (OAST) on November 16, 1983, at NASA Headquarters. It was determined that upgraded range tests were required for comparison of data with existing FAA radar range data.

Action

Dr. Zuckerwar is preparing a proposal to Technology Utilization for support of more extensive testing of the existing system before presentation to FAA.

PORTABLE X-RAY FLUORESCENCE SPECTROMETER (PXRFS) AS A METALS ANALYZER

RTI Team Personnel: Dr. H. Clark Beall

Problem

Each element of the periodic table exhibits a unique fluorescence spectrum. A mixture of elements, such as that found in an alloy of metals, can be determined by measuring the X-ray fluorescence from the alloy and calculating from the spectra the exact ratios of concentration of the constituent metallic elements. This task usually requires laboratory-based instrumentation. Many industrial situations (aircraft manufacture and repair, shipbuilding, nuclear power plant sites, and metal stock yards) require the verification of metal alloys in situ in large pieces of partially assembled hardware. Also, the American Iron and Steel Institute (AISI) has indicated a need for an instrument for use in performing in-process analysis of molten steel blends.

Solution

A portable system capable of obtaining X-ray fluorescence spectras without a laboratory environment is required.

NASA Technology

A portable X-ray fluorescence system was developed for the Viking mission. This technology has been applied to the analysis of heavy metals in a joint NASA/EPA project (RTOP 141-20-10-30) and to the analysis of metal ores in a joint NASA/Bureau of the Mines project (RTOP 141-95-01-25).

Principals

Warren C. Kelliher, NASA Langley Research Center, Hampton, Virginia.

Cost to NASA

A total of $97,000 has been approved for FY83 and FY84.

Commercialization Strategy

A workshop to demonstrate the prototype system is scheduled for September 1983. Department of Defense and other user groups as well as manufacturers will be invited to participate.

Status

Canberra has been selected for procurement of the electronics package. Delivery is expected in February 1984.

Action

The Canberra pulse height analyzer will be evaluated. System integration and evaluation will continue in the next quarter.

PORTABLE X-RAY FLUORESCENCE SPECTROMETER (PXRFS) FOR WATER QUALITY MONITORING

RTI Team Personnel: Dr. H. Clark Beall

Problem

Monitoring of hazardous waste sites currently requires the shipping of onsite samples to a laboratory for analysis. The inability to screen samples onsite presents problems in selection of shipping containers, collection methods, and shipping options.

Solution

A portable system for screening hazardous waste samples for specific toxic elements would improve the effectiveness and efficiency of monitoring efforts.

NASA Technology

A portable X-ray spectrometer was developed for use in the Viking Lander experiments. An adaptation of this technology could be applied to water quality monitoring.

Principals

Warren C. Kelliher, NASA Langley Research Center, Hampton, Virginia.

Cost to NASA

NASA has allocated $200,000. EPA has contributed $199,000 through 1984.

Commercialization Strategy

Martin-Marietta is working with Langley in the development of the system and is currently interested in licensing for manufacturing and marketing.

Status

Detectors are being purchased from Princeton Gamma Technologies and Ortec for comparison. The X-ray tube has been developed by X-Tech under a Martin-Marietta subcontract. The detector, X-ray tube, and electronics are currently being integrated into a prototype system.

Action

A demonstration of the system is scheduled for March 1984. Field tests are scheduled for April 1984 through June 1984.

WASTEWATER TREATMENT BY VASCULAR AQUATIC PLANTS

RTI Team Personnel: Dr. H. Clark Beall

Problem

The purification of wastewater is a problem faced by municipal treatment plants throughout the United States. The effluent from such plants must meet standards set by EPA before it can be released from the treatment plant. Sanitation engineers are searching continually for new technologies that can be applied to water treatment to reduce costs, time, and energy required to process wastewater.

Solution

Use of aquatic plants, one of several new procedures for wastewater treatment, shows promise in terms of speed, operating cost, and effectiveness.

NASA Technology

Research at the National Space Technology Laboratories has focused on the treatment of wastewater by vascular aquatic plants.[1] The first effort dealt with a system based on the water hyacinth, Eichhornia crassipes. This system worked well in warm climates in wastewater treatment and biomass energy production.

Principals

Bill Wolverton, Ph.D., National Space Technology Laboratories, Mississippi.

Cost to NASA

NASA's cumulative funding has been $50,000. Funding from other sources has been $300,000.

Commercialization Strategy

The City of San Diego is now using the water hyacinth system as one means to bring effluent water to potable standards. An engineering firm from Baton Rouge, Louisiana, Owens and White, Inc., has based its designs for two new municipal treatment plants on the NASA-published data of microorganism/vascular plant wastewater treatment.

Status

The NASA research effort now focuses on the utilization of reeds, rushes, and cattails as more cold-hardy vascular plants for wastewater treatment. The vascular plant systems are also useful in treating input water from contaminated rivers for the elimination of chlorinated organics and heavy metals.

Action

The RTI team recently has introduced the NASA technology to the Industrial Technology Research and Development Innovation Center of Durant, Oklahoma, as an item of appropriate technology for rural applications. The RTI team has also introduced the technology to the North Carolina Highway Department for their consideration for wastewater treatment at remote highway rest stops.

Reference

1. Wolverton, B. C. New Hybrid Wastewater Treatment System Using Anaerobic Microorganisms and Reed (Phragmites communis). NASA Technical Memorandum, TM-X-72739, June 1981.

WILDLIFE TRACKING

RTI Team Personnel: Drs. John Cleland and H. Clark Beall

Problem

Tracking of wild animals to determine range, activities, and biocharacteristics is often labor-intensive and limited by the efficiency of current transmitter/receiver systems. The development of an improved tracking system, incorporating automated data acquisition and analysis, also lends itself to a much broader commercial market (e.g., police vehicle monitoring).

Solution

The initial phases emphasize design and demonstration of a key technical concept improving the state-of-the-art. In consideration of support by North Carolina and Federal Wildlife Services, and availability of an ideal testing site in the Pisgah National Forest, tracking of wild black bears is planned for initial technology demonstration.

NASA Technology

Telecommunications developments at Kennedy Space Center (KSC), Goddard Space Flight Center, and Jet Propulsion Laboratory have been surveyed. Recent emphasis has been placed on high frequency directional finding, time-of-arrival, and Loran C Systems.

Principals

U. Reed Barnett, Kennedy Space Flight Center, Technology Utilization Office.
Larry Kolz, Denver Wildlife Research Center, U.S. Fish and Wildlife Service.
John Bowling, Wood-Ivey Systems Corporation (WISCO), Winter Park, Florida.
John Collins, Big Game Coordinator, North Carolina Fish and Wildlife Commission, Morganton, North Carolina.
Roger Powell, Ph.D., Zoology Department, North Carolina State University, Raleigh, North Carolina.

Cost to NASA

NASA funding to WISCO for Phases 1 and 2 is $25,000. The U.S. Fish and Wildlife Service is providing an additional $22,000. Phase 1 began in October 1983, and Phase 2 will be completed in July 1984.

Commercialization Strategy

A manufacturer will be identified following the technology demonstration. Both wildlife tracking and broader commercial markets will be surveyed under Phases 1 and 2.

Status

A statement of work was completed by WISCO. Technology research and tracking system vendors have been surveyed. Results from tracking tests in (and terrain definition of) the Pisgah National Forest have been obtained. Discussions were held with KSC engineers on LORAN. A meeting of all principals was held in Asheville, North Carolina, on November 8-9, 1983. KSC, WISCO, and RTI principals met in Winter Park, Florida, on December 21. A market survey plan is under preparation by the RTI team. A Phase 1 report is being prepared for delivery in February.

Action

WISCO is to submit a Phase 1 report and identify the key technical concept. Phase 2 design, testing and market surveys will proceed. The RTI team plans to participate in the Phase 1 review at KSC in February 1984.

5.0 INACTIVATED PROJECTS

FRACTURE SUPPORT SYSTEM

RTI Team Personnel: Dr. H. Clark Beall

Mr. Lew Dillon-Townes, an engineer with the NASA Langley Systems Development Section, compared the performance specifications of the newest type of fracture support rod with the desired structural parameters. His computer simulation showed that the rod's measured characteristics were very close to the theoretical maximum performance limits, given the rod's diameter, taper, and material. He determined that technology was not available that could radically improve the newest types of rods being developed.

6.0 SPECIAL ACTIVITIES

INSTRUMENTATION FOR ULTRASOUND DIAGNOSIS OF BURN DEPTH

A NASA Langley Technology Utilization project, ultrasound diagnosis of burn depth, required the specification, acquisition, and evaluation of ultrasound instrumentation. The RTI team had worked closely with the Langley scientists, manufacturers, and the clinical user community in the development of this project. NASA Langley thus requested that the RTI team assist in the selection, delivery, and testing of the instrumentation. Specifications for the instrumentation and the required modifications were developed with the NASA Langley scientists. The major components were delivered to Langley in January 1984. A digital scan converter, however, will not be available for 2 to 3 months. When all of the instrumentation components are obtained, the RTI team will participate in an instrumentation evaluation at NASA Langley and will document the results.

NASA-DENT

In the course of searching NASA Technology for items that would be applicable to the maintenance of dental hygiene in the handicapped population, the RTI team documented the commercial introduction of NASA-Dent by Scherer Laboratory of Dallas, Texas, in January 1983. This nonfoaming, ingestable dentrifice is especially useful as a first dentrifice for children. It is also useful for institutionalized patients who cannot safely use ordinary toothpaste.

NASA-Dent was developed by Dr. Ira L. Shannon, a dentist who was the director of the Oral Physiology Laboratory, VA Hospital, Houston, Texas. Dr. Shannon was contracted by NASA (NAS-9-10566) to develop special dental care products for astronauts. Dr. Shannon has also developed a water-free 0.4% SnF_2 gel for caries prevention called "Gel-Kam." This product is also produced for the institutional market by Scherer Laboratory.

The RTI team has brought these products to the attention of the NASA Dissemination and Analysis Office for Publication in the 1984 issue of Spinoff.

PUBLIC SERVICE HELICOPTER TECHNOLOGY UTILIZATION PROGRAM

The NASA Technology Utilization Office and the Office of Aeronautics and Space Technology have joined together through the Ames Research Center to sponsor an effort by industry to identify those technologies that could stimulate the development of an improved public service helicopter.

This effort, called the Public Service Helicopter Technology Utilization Program (PSHTU), currently focuses on the emergency medical uses of helicopters. With the cost of trauma in excess of $87 billion per year, the benefit of a properly designed and equipped emergency helicopter is well documented. RTI team consultant, Mr. Bernard Maggin, has worked closely with NASA Ames and NASA Headquarters to plan a program that would identify the requirements and applicable technology for advanced public service helicopters.

In addition, the RTI team has been working with the Ames group to define further the problem areas of the onboard medical equipment and develop projects that would improve the inflight patient care and/or cost of service. As part of this problem definition, the Technology Utilization Office is sponsoring a medical equipment needs workshop that will be directly organized by the Aerospace Medical Association and the RTI applications team. Participants will include industry representatives, Department of Defense, National Institute of Neurological, Communicative Disease and Stroke; and the National Institute of Handicapped Research.

Next quarter action includes participation in this workshop and workup of the workshop recommendations toward full project status.

7.0 CONCLUSIONS

During the reporting period, the RTI Technology Transfer Team conducted problemsolving and commercialization activities for 18 active projects. Each of these projects has the potential for introducing new or improved commercial devices incorporating NASA technology. The projects selected by the team reflect an emphasis on transferring NASA technology by the development of commercially available devices, thus achieving widespread availability of the spinoffs developed in NASA's Technology Utilization Program. In the past year, NASA's team at RTI has expanded its technology transfer activities to include the application of aerospace technology to manufacturing as well as rehabilitation and medicine. The team, therefore, has directed considerable effort toward the development of effective approaches to project identification and implementation of transfer activities in manufacturing. The objective of the manufacturing technology transfer program is to reduce the costs and enhance productivity of U.S. industry by the development of new machinery, material, or processes incorporating aerospace technology. The technical approach developed by the RTI team is summarized in Section 2 of this report.

Experience in this program has indicated that successful technology transfer requires the RTI team to identify and coordinate the participation of those organizations and agencies responsible for addressing the technology requirements of industry. These organizations are important in the identification of appropriate projects and the adaptation of aerospace technology to meet industry's requirements. In the past year, the RTI team has initiated discussions with the following industry organizations: Electronic Industry Association, Society of Manufacturing Engineers, Machine Tool Builders Association, and the Semiconductor Research Corporation. All of these groups have expressed considerable enthusiasm for participation in NASA's Technology Utilization program. A positive response has also been expressed by the Federal agencies contacted by the RTI team such as the Department of Commerce and the Department of Defense. The RTI team strongly recommends continued collaboration with these and other industry associations and agencies based on their anticipated contributions in the following areas:

- Definition of the technical requirements of highest priority to industry
- Advising the team in the formulation and implementation of strategies for cofunding and developing solutions to technical requirements
- Identification and facilitation of access to other individuals in their organization for consultation and participation on specific projects as needed.

8.0 TRAVEL

December 6-7, 1982	Dr. Doris Rouse participated in an Advisory Design Committee Meeting for the Association for Retarded Citizens in Arlington, Texas.
January 18, 1983	Dr. H. Clark Beall visited Langley Research Center to discuss application of NASTRAN computer programs.
January 18, 1983	Dr. Doris Rouse met with Dr. A. Munster at the Baltimore City Hospital to discuss the Ultrasound Diagnosis of Burn Depth project.
January 25, 1983	Dr. H. Clark Beall met with Reed Barnett and Mr. Castle at Southwest Research Institute in San Antonio, Texas, to discuss the Wildlife Tracking project.
February 23, 1983	Dr. Doris Rouse met with Dr. Paul Sugarbaker, National Cancer Institute, to discuss colonoscope technology and the colostomy sphincter.
February 24, 1983	Dr. Doris Rouse met with Don Friedman and Ray Whitten at Goddard Space Flight Center to discuss new projects.
March 22, 1983	Dr. James N. Brown, Jr., and Dr. Doris Rouse met with Ray Whitten and Don Vargo at NASA Headquarters to discuss Technology Transfer Team projects.
March 31, 1983	Dr. Doris Rouse met with Don Friedman at Goddard Space Flight Center to discuss Functional Electrical Stimulation with Dr. Hunter Peckham of Case Western Reserve University and Frank Coombs of the Veterans Administration.
April 5-6, 1983	Dr. Doris Rouse met with John Samos at Langley Research Center to discuss Technology Transfer Team projects.
April 7, 1983	Dr. Doris Rouse and Drs. John Cantrell and Tom Yost from Langley Research Center met with Dr. Boyd Haynes, Jr., Director of the Burn Unit at the Medical College of Virginia to discuss clinical evaluation of the ultrasound burn analysis systems.
April 21-22, 1983	Dr. Doris Rouse visited the Veterans Administration Rehabilitation Engineering Center in New York, New York, to discuss orthopedic footwear prescription and fabrication methods and wheelchair testing methods.

April 22, 1983	Dr. H. Clark Beall visited Mr. John Samos and Mr. Dillon-Townes at Langley Research Center to discuss project plans for the Fracture Support System Project.
April 26, 1983	Dr. Doris Rouse participated in a National Prosthetics and Orthotics Workshop in Washington, D.C., that was sponsored by the Veterans Administration.
May 13, 1983	Dr. Doris Rouse met with Mr. Ed Mueller of the Food and Drug Administration to discuss Technology Transfer Team projects.
May 23, 1983	Dr. James N. Brown, Jr., met with Chrysler Corporation Research and Development engineers in Detroit to discuss the NASA Technology Utilization Program.
June 11-16, 1983	Dr. Doris Rouse participated in the Rehabilitation Engineering Society of North America Meeting in San Diego, California. During this week, Dr. Rouse participated in a planning session conducted by Don Friedman on Functional Electrical Stimulation.
June 30, 1983	Mr. Art Keating and Dr. Doris Rouse participated in a planning session at NASA Headquarters on Public Safety Helicopters.
July 14-15, 1983	Dr. Doris Rouse met with Ray Whitten, Ray Gilbert, and Don Vargo at NASA Headquarters for project discussions.
July 25, 1983	Dr. H. Clark Beall attended a technical review at the Marshall Space Flight Center Technology Utilization Office on the proposed technology for the corneal topography project.
July 25, 1983	Mr. Art Keating met with Dr. Richard Melkar and Healthdyne representatives in Gainesville, Florida, to discuss equipment requirements for MEDEVAC helicopters.
July 27, 1983	Clark Beall participated in a briefing at Goddard Space Flight Center Technology Utilization Office for representatives of outdoor camps and special education facilities for the handicapped.
July 27, 1983	Mr. Art Keating and Dr. Doris Rouse made a presentation on NASA Biomedical Spinoffs at the South Carolina Conference for Health Occupations in Columbia, South Carolina.
August 2, 1983	Mr. Art Keating and Dr. Doris Rouse made a presentation on NASA Biomedical Spinoffs at the North Carolina Health Occcupation Educators Meeting in Charlotte, North Carolina.

August 10, 1983	Mr. Bill Penland and Dr. Doris Rouse met with Colonel Camp, U.S. Army Medical R&D command, at Fort Detrick in Frederick, Maryland, to discuss equipment requirements for MEDEVAC helicopters.
August 18, 1983	Dr. James N. Brown, Jr., and Dr. Doris Rouse met with NASA Headquarters staff to discuss Technology Transfer Team projects.
August 24, 1983	Dr. Doris Rouse met with RTI consultant, Bernard Maggin, to discuss project management.
October 13, 1983	Dr. Doris Rouse met with Ray Whitten at NASA Headquarters to discuss applications engineering projects.
September 16, 1983	Dr. Doris Rouse visited Langley Research Center in Hampton, Virginia, to discuss project plans with John Samos, Les Rose, and several project leaders.
September 27, 1983	Mr. Robert Wallace visited Johnson Space Center for discussions with Mr. Marvin Matthews and Mr. Bill Chymlak in the Technology Utilization Office and Mr. Harry Erwin on robotic laser tracking systems.
October 13, 1983	Dr. Doris Rouse met with Ray Whitten in Washington to discuss project activities.

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15. Supplementary Notes

Langley Technical Monitor: John Samos
Final Report - November 23, 1982-December 31, 1983

16. Abstract

The objective of the Research Triangle Institute (RTI) Technology Transfer Team is to assist NASA in achieving widespread utilization of aerospace technology in biomedical and terrestrial applications. Widespread utilization implies that the application of NASA technology is to benefit a significant sector of the economy and population of the Nation. This objective is best attained by stimulating the introduction of new or improved commercially available devices incorporating aerospace technology.

A methodology is presented for the team's activities as an active transfer agent linking NASA Field Centers, industry, industry associations, user groups, and the medical community. This methodology is designed to (1) identify priority technology requirements in industry and medicine, (2) identify applicable NASA technology that represents an opportunity for a successful solution and commercial product, (3) obtain the early participation of industry in the transfer process, and (4) successfully develop a new product based on NASA technology.

For the convenience of the reader, the names and addresses of the sources of commercial products are included in this report. This listing does not constitute an endorsement by either the National Aeronautics and Space Administration or the Research Triangle Institute.

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